

UNITED STATES  
AIR FORCE

# environmentally responsible

Sustainability is responsible stewardship of

our natural, human and financial resources

through a practical and balanced approach.

Sustainability requires changes to the facility

delivery process to ensure the “best fit”

of the built environment to the natural

environment.

Sustainable practices are an investment in

the future. Through conservation, improved

maintainability, recycling, reduction, reuse

and other actions and innovations, we can

meet today's needs without compromising

the ability of future generations to meet

their own.

## FACILITIES GUIDE



# audience for this guide

This Guide is directed to programmers, planners, designers, project managers, energy managers, environmental managers, facility users, A/E consultants and constructors. The Guide provides an introduction to the environmental challenges faced in planning, programming, designing and constructing facilities. It addresses facility- and site-related issues. It is intended to be a practical tool for implementing environmentally-responsible practices. It is written from a process- and action-oriented viewpoint.

# use of this guide

The Guide serves as a supplementary tool for the project, in addition to other special design requirements and criteria, and will complement the existing facility delivery process. It references other applicable Air Force documents as appropriate.

The Guide is designed to serve as a checklist of ideas and procedures to be used throughout the facility delivery process. It allows the project team to quickly begin the process of setting priorities and goals for the project and to comply with Executive Orders and acquisition policy.

The concepts and opportunities presented are applicable to the full range of new construction and renovation projects. Although the processes may differ slightly, the concepts in this Guide may be applied to Military Construction (MILCON), Operation and Maintenance (O & M), Military Family Housing and Non-Appropriated Funding (NAF) projects.

# organization of this guide

This Guide is organized to be integrated with the current steps in the facility design and delivery process, as described in the USAF Project Manager's Guide for Design and Construction. See Graphic in Chapter One.

The Guide is arranged to track the life of an Air Force facility. It directs the





reader, using established Air Force procedures, through initial planning, design, construction, commissioning, daily operation and, finally, reuse or demolition.

In each chronological section there is a summary of the section followed by a list of referenced documents. The main body of each section is a list of action items with references noted.

Where applicable, Tools for evaluation or organization of an item are referenced. These Tools are included in the Appendices. Examples of existing Air Force sustainability initiatives are given throughout the Guide.

Most reference documents can be obtained from the Air Force Center for Environmental Excellence (AFCEE) PRO-ACT Environmental Information Clearinghouse. See also the Air Force Civil Engineering Support Agency (AFCESA) World Wide Web Home Page for referenced Engineering Technical Letters (ETLs) and guidance from the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

Bases should have a master file of ETLs and ASHRAE guidance, as well.

Construction Criteria Base (CCB) is available at the Web Page, and AFCESA provides for distribution of complete set of disks to each base quarterly.

A glossary of acronyms is also included. Certain specialized terms, e.g., *life cycle*, are highlighted in the text. Definitions of these special terms may be found under "Definitions."

We trust you will find the organization and contents of the Guide to be user-friendly and practical. The overriding objective is for all Air Force facilities to be designed, built and/or renovated incorporating the principles of sustainability and environmentally responsible design and construction.

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THE FOLLOWING TOOLS ARE PROVIDED SEPARATELY FOR DOWNLOADING  
AS MS WORD FILES. THIS WILL PROVIDE THE READER WITH THE FLEXIBILITY  
TO MODIFY AND INTEGRATE THESE DOCUMENTS AS NEEDED.

A . . . . .STATEMENT OF WORK AND A/E SELECTION TOOL

B . . . . .DESIGN SOLUTION DOCUMENTATION TOOL

C . . . . .ENVIRONMENTALLY PREFERABLE  
BUILDING MATERIALS TOOL

D . . . . .LIFE CYCLE COST ANALYSIS REFERENCE TOOL

E . . . . .PROJECT COMMISSIONING TOOL

F . . . . .POST-OCCUPANCY EVALUATION TOOL

G . . . . .CONSTRUCTION & DEMOLITION  
ECONOMICS WORKSHEET TOOL

supporting information

FOR MORE SUPPORTING INFORMATION ON THE SUBJECT OF SUSTAINABLE  
DESIGN, SEE AFCEE WEBSITE AT [WWW.AFCEE.BROOKS.AF.MIL](http://WWW.AFCEE.BROOKS.AF.MIL)



There are already many individual environmental initiatives within the Air Force. There are also previously created resources, such as the Passive Solar Guide, which are very useful tools.

This Air Force environmentally responsible facilities guide will serve to extend existing initiatives and resources by giving them wider exposure and by providing for the systematic inclusion of these and other environmental policies into the delivery of all facilities. This Guide should provide the framework to link Comprehensive Planning (AFI 32-7062) and the Environmental Impact Analysis Process (EIAP) (AFI 32-7061) to the existing facility delivery process.

This Guide is a compendium of ideas to use in complying with the mandate of Executive Order (EO) 12873. It is intended as a guide only; for now, there are few prescriptive regulatory requirements. Policy is discussed in the following pages.

Each facility will offer its own unique challenges. The concepts and tools selected for each individual project will be those which best address these challenges, prove to be most effective and achieve the finest results.

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Sustainability is responsible stewardship of our natural, human and financial resources through a practical and balanced approach. Sustainability requires changes to the facility delivery process to ensure the “best fit” of the built environment to the natural and cultural environment.

Sustainability integrates “green” or environmentally responsible practices into the process from the very beginning.

Sustainable practices are an investment in the future. Through conservation, improved maintainability, recycling, reduction, reuse and other actions and innovations, we can meet today’s needs without compromising the ability of future generations to meet their own.

Commitment to sustainable design requires the following actions:

- ..... Expanding our focus to include *life cycle* costs along with first costs.
- ..... Extending the life of facilities.
- ..... Changing the facility delivery process to minimize waste.
- ..... Breaking down the traditional individual discipline stovepipes and working as a team from the beginning.

AIR FORCE  
INTEREST IN  
SUSTAINABLE  
DESIGN

The Air Force will comply with sustainability guidelines in developing new facilities and renovating existing facilities for the following four reasons:

**1. POLICY MANDATES** — Executive Orders and acquisition policy require the Air Force to implement appropriate sustainability practices. However, few of these have been translated into specific regulations (with the exception of recycled-content material requirements). “The Department of Defense (DOD) must improve its environmental performance by actively implementing policies that embrace pollution prevention in all phases of the acquisition process, the procurement of goods and services and in the life-cycle management of our installations.” — The Secretary of Defense, Aug. 11, 1994.

**EXECUTIVE ORDER (EO) #12873** — “In developing plans, drawings, work statements, specifications, or other product descriptions, agencies shall consider the following factors: elimination of virgin material requirements; use of recovered materials; reuse of product; *life cycle* cost; recyclability; use of environmentally preferable products; waste prevention (including toxicity reduction or elimination); and ultimate disposal, as appropriate. These factors should be considered in acquisition planning for all procurements and in the evaluation and award of contracts, as appropriate. Program and acquisition managers should take an active role in these activities.” — Section 401.

**EXECUTIVE ORDER #12902** — “Each agency involved in the construction of a new facility that is to be either owned by or leased to the Federal Government shall design and construct such facility to minimize the *life cycle* cost of the facility by utilizing energy efficiency, water conservation, or solar or other renewable energy technologies.” — Section 306. This Order further requires each agency to establish and implement a facility commissioning program to ensure that construction of new facilities meets the requirements outlined in the Order before the facility is accepted into the federal facility inventory.



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40 CODE OF FEDERAL REGULATIONS (CFR) 247 —  
COMPREHENSIVE PROCUREMENT GUIDELINE (CPG)

This is the first formal regulation implementing sustainability requirements.  
We expect more to follow.

The Environmental Protection Agency (EPA) has designated 36 items that are,  
or can be, manufactured using recycled and recovered materials. Construction,  
landscaping and park and recreation products are among the designated items.  
(Refer to AFCEE website for current listings.)

Federal agencies are required to purchase EPA-designated items

recycled

meeting minimum recycled-content standards unless they are not available  
within a reasonable period of time; fail to meet reasonable specification stan-  
dards; are not available from two or more sources (to maintain competition);  
or are unreasonably priced (costing more than comparable non-recycled prod-  
ucts). Recycled-content purchase requirements are discussed in more detail in  
*A Guide to Buying Recycled: The Air Force Affirmative Procurement Program*  
(HQ AFCEE, June 1997).

2. **MISSION** — It is part of our mission. The health of our people and our  
environment is basic to the survival of the United States. Increased Air Force  
worker health and productivity translates into increased mission capability.

3. **LEADERSHIP** — Air Force personnel have the training, knowledge,  
experience, capacity and foresight to be the leaders in effectively addressing the  
challenge. Our personnel are already used to thinking in terms of quality and  
long-term serviceability. We demonstrate wise financial stewardship, as opera-  
tional costs are reduced over the life span of the facility.

4. **NATIONAL STRATEGIC OPPORTUNITY** — Sustainability  
offers the United States another opportunity to lead the world. The space pro-  
gram generated major scientific advances in computers, communications and  
other fields. These advances have contributed greatly to the industrial strength  
of the United States for over 40 years. The environmental revolution and the  
advances that are even now resulting have a similar capacity to maintain the  
U.S. technological edge into the next century.

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## ECONOMIC BENEFITS OF SUSTAINABLE DESIGN

There are significant benefits to be gained in environmentally responsible or sustainable design. It can mean better overall performance and lower ongoing costs.


It can also lead to more pleasing, healthy and productive facilities for the users, with good quality air, natural light enhanced by artificial light and more pleasant environments. Numerous studies connect healthy facilities to increased productivity (See *Lean and Clean Management* by Joseph J. Romm, Kodansha Publishing Co., Japan and New York, 1994). Productivity increases of up to 15% have been reported in studies by the Rocky Mountain Institute (see “Greening the Building” and “The Bottom Line: Increasing Productivity through Energy-Efficient Design,” by Joseph J. Romm, U.S. Dept. of Energy, and William D. Browning, Rocky Mountain Institute, Dec 1994, p. 1).

Even if sustainable design requires initial added expense, when viewed over the *life cycle* of the structure, it pays for itself and more. Economic benefits include energy, water and material savings, as well as reduced maintenance and other operational costs.

## ENVIRONMENTAL IMPACTS OF AIR FORCE FACILITIES

Worldwide, the Air Force maintains and manages thousands of facilities on nearly two hundred installations. In fiscal year 1996, the Air Force constructed 222,960 square meters (SM) (2.4 million square feet (SF)) of new facilities and renovated one million SF of existing facilities. The majority of these facilities have environmental impacts similar to those of the rest of the building industry.

Facilities significantly contribute directly and indirectly to many of our environmental challenges. According to published reports (*A Building Revolution: How Ecology & Health Concerns are Transforming Construction* by David Malin Roodman and Nicholas Lenssen, World Watch Institute, 1995, Washington, D.C.), facilities in the United States use 17% of the total freshwater flows and 25% of harvested wood; are responsible for 50% of chlorofluorocarbon (CFC) production; use 40% of the total energy flows; generate 33% of carbon dioxide (CO<sub>2</sub>) emissions; and generate 40% of landfill material from construction waste.

 According to the Environmental Protection Agency (EPA),

one-third of all facilities suffer from sick facility syndrome.

While statistics differ, there is widespread agreement in the scientific community on the overall trends. It is only prudent that we move away from policies and practices which contribute to these concerns. For nearly every facility and system there are alternatives. These have differing environmental impacts. In most cases, there are practical and affordable solutions that are significantly better in meeting environmental needs than the heretofore standard practice.

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There are relatively easy ways to improve in almost every area with minimal impact on cost or scope. Increased initial costs associated with design and construction can be programmed into projects, with *life cycle* cost as the measuring tool. Team members are encouraged to look beyond “first cost” and ask “How long will it last?” Higher initial costs in design and construction will diminish as common procedures are adopted.

GOALS

The overall goal is not just to produce environmental demonstration projects, but to move toward being environmentally responsible in the delivery of all Air Force facilities.

The key traditional elements for decision making in the facility delivery process are cost, quality and time. These criteria for decision making need to be expanded to include the ecological and human health impact of all decisions.

Each project will generate its own set of goals; however, there are some goals which should apply to all projects. These overall goals for improving the environmental performance of facilities include:

- 1. To use resources efficiently and to minimize raw material resource consumption, including energy, water, land and materials, both during the construction process as well as throughout the life of the facility.
- 2. To maximize resource reuse, while maintaining financial stewardship.
- 3. To move away from fossil fuels and towards renewable energy sources.
- 4. To create a healthy working environment for all who use the facility.
- 5. To build facilities of long-term value.
- 6. To protect and, where appropriate, to restore the natural environment.

As goals for an individual facility are developed and proven effective, they should be incorporated into the Installation Design Standards, so that other facility design teams may benefit from them and the concepts may be applied as appropriate to all future projects. This is an iterative process, with goals and standards continually evolving as sustainable breakthroughs are achieved.

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Please pay special attention to the following key areas as you work your way through this Guide in order to maximize the results of sustainable design:

**1. TEAM FORMATION** — Include an interdisciplinary team, under the leadership of the Engineering Flight, from the beginning of the project to achieve a common understanding of environmental concerns and opportunities and for goal setting. In addition to the Architect/ Engineer (A/E) team, this should include environmental managers, energy managers, construction managers, operations personnel and key consultants, as well as the users. Only through an interdisciplinary approach can true sustainability be achieved. All members of this team should participate in initial goal setting and should also attend the design charrette.

**2. EDUCATION AND GOAL SETTING** — Set clear and specific environmental goals for the project. Quantify goals wherever possible, for example, energy use, water use and allowable levels of volatile organic compounds (VOC) emissions. Educate the entire team about environmental restrictions and opportunities. Goal setting also implies setting priorities.

**3. DESIGN DEVELOPMENT** — As the design progresses, systematically evaluate each component and process to achieve the highest performance with the least expenditure of resources. Use the team approach, measuring the progress of the design by the goals set at the beginning of the project.

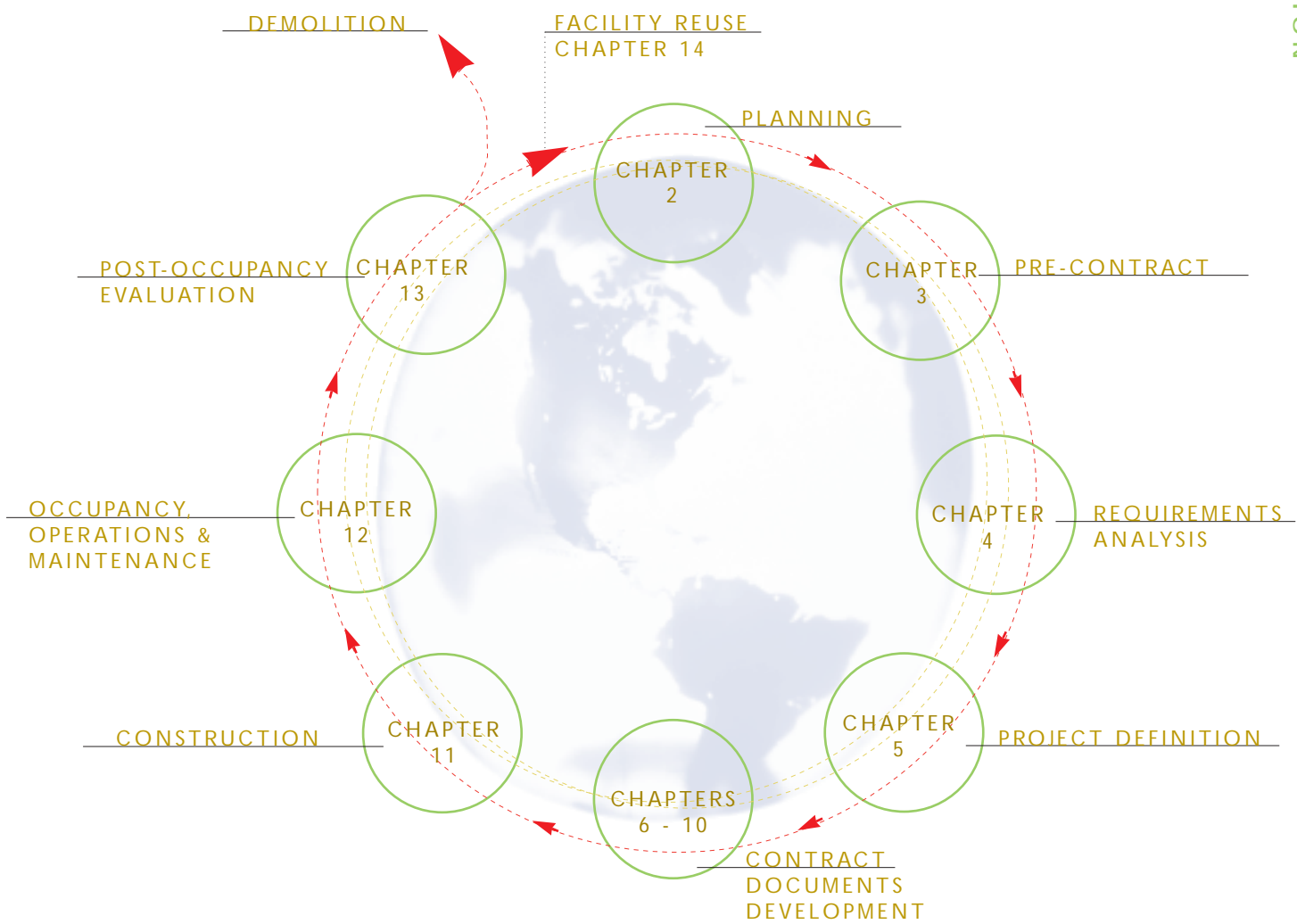
**4. DOCUMENTS AND SPECIFICATIONS** — Many of the products, processes and allowable criteria for improved environmental performance will be new. Many specifications will be relatively new and require extra care. See Resource List and Statement of Work Sample Tool for guidance in developing environmentally considered specifications.

**5. CONSTRUCTION** — Many of the products, processes and procedures to be used will be new to many in the construction industry. During this phase, suppliers, sub-contractors and others enter the picture. The sharing of environmental goals and objectives must extend to this new group through detailed specifications, as well as partnering.

**6. OPERATIONS AND MAINTENANCE** — Once again, the issue of team formation and the early involvement and education of those ultimately responsible for the operations and maintenance of the facility become critical. Many studies have shown that there are substantial opportunities to save energy if facilities were simply operated as originally intended.

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phases of sustainable design related to AF process



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## INTRODUCTION

During the planning phase, needs and facility requirements are defined, an environmental impact analysis is conducted (as required by the National Environmental Policy Act (NEPA)), a site is selected and a project cost is developed. The Environmental Impact Analysis Process (EIAP) implements NEPA and requires that you consider alternatives during the planning phase.

Sustainable Design should be considered in developing the Comprehensive Plan. The EIAP is most effective when integrated with the base long-range planning process.

The Requirements Document (RD) and the Project Management Plan (PMP) together comprise the Requirements and Management Plan (RAMP). Air Staff's 25 Oct 95 memo ("Use of Parametric Cost Estimates in Preparation of DD Form 1391s for FY98 and FY99 MILCON") requires that the Department of Defense Form 1391c (DD Form 1391c) be developed and validated by the Air Force Parametric Cost Engineering System (PACES) and RD. In completing these documents and forms, key decisions regarding the facility's budget, site, location and size impact the potential for meeting sustainable design objectives.

As a team effort between Engineering and Environmental Flights, jointly prepare a Sustainability Goals document outlining goals and priorities for sustainable design and construction. (See sample document at AFCEE website.) Include the Sustainability Goals in DD Form 1391 scope and budget. Seek additional funding, for example, for cost-effective energy conserving measures which have higher first costs, but lower *life cycle* costs. Though there may be some additional cost, the earlier in the design process this is addressed, the more likely the cost can be minimized. Also, look at *life cycle* cost, rather than only first costs.

During site selection, look for opportunities to restore neglected sites and limit negative impacts to unbuilt sites. Consider the relationship of the proposed facility to the larger context of the base and the community, to maximize flexibility to accommodate future needs and to reduce base transportation energy requirements.

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- ..... Air Force Energy Program Procedural Memorandum (AFEPPM) 96-1: Air Force Energy Management Plan, 1 Jun 96.
- ..... AFEPPM 96-4: Investment Opportunity for Energy and Water Conservation Projects, 14 Feb 96.
- ..... Air Force Instruction (AFI) 32-7061: The Environmental Impact Analysis Process (EIAP).
- ..... Air Staff's Memo, 21 Oct 94, "Oil/Water Separator/s Operations, Maintenance and Construction".
- ..... Air Staff's Memo, 22 Dec 93, "Fire Training Facility Minimum Requirements".
- ..... Air Staff's Memo, 1 Sept 95, "Double Liner and Leak Detection System Requirement for New Aircraft Crash Fire Rescue Training Facilities (CFRTFs)".
- ..... AFI 32-7062: Comprehensive Planning.
- ..... Base Pollution Prevention Management Action Plan (P2MAP).
- ..... Construction Criteria Base (CCB), most current release, for energy and utility conservation guidance.
- ..... Environmental Protection Agency (EPA) Comprehensive Procurement Guideline (CPG), AFCEE website.
- ..... Executive Order (EO) 12873, Federal Acquisition, Recycling and Waste Prevention; <http://denix.cecer.army.mil/denix/Public/Library/P2-Manager/toc.html>
- ..... Engineering Technical Letter (ETL) 84-7: Military Construction Program (MCP)
- ..... Energy Conservation Investment Program (ECIP), 13 June 84.
- ..... ETL 87-2: Volatile Organic Compounds, 4 Mar 87.
- ..... ETL 88-3: Design Standards for Critical Facilities, 15 Jun 88.
- ..... ETL 88-9: Radon Reduction in New Facility Construction, 7 Oct 88.
- ..... ETL 89-6: Power Conditioning and Continuation Interfacing Equipment (PCCIE) in the MCP, 7 Sep 89
- ..... ETL 90-6: Electrical System Grounding, Static Grounding and Lightning Protection, 3 Oct 90.
- ..... ETL 90-10: Commissioning of Heating, Ventilating and Air Conditioning (HVAC) Systems Guide Specification, 17 Oct 90.
- ..... ETL 91-7: Chlorofluorocarbon (CFC) Limitation in Heating, Ventilating and Air Conditioning (HVAC) Systems, 21 Aug 91.
- ..... ETL 93-5: Fire Protection Engineering Criteria - Electronic Equipment Installations, 22 Dec 93.
- ..... ETL 94-4: Energy Usage Criteria for Facilities in the Military Construction Program (MCP), 19 Aug 94.
- ..... ETL 94-7: EPA Guideline Items in Construction and Other Civil Engineering Specifications, 14 Dec 94.
- ..... ETL 95-2: Preparation Requirements and Management Plan (RAMP) Packages for Military Construction (MILCON) Program Projects, 26 Oct 95.
- ..... Installation Pollution Prevention Program Guide, July 1996.
- ..... USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.

[LCCA]  
cost-effective

- A. 1. — Identify environmental goals and requirements to be implemented during the design process, and include them in the RAMP document. Consider using the U. S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) Building Rating System as an outline of environmental performance targets for the project. See the Post-Occupancy Evaluation Tool for a summary of the LEED system and references.
- A. 2. — Integrate project planning and goal setting with base Pollution Prevention (P2) program. Use the decisions made during the planning and design process to support base-wide reduction in Ozone Depleting Substances (ODS), the EPA 33/50 Program (a voluntary program targeting 17 chemicals for reduction), and reduction in hazardous and solid waste and pesticide use.
- A. 3. — Budget for environmental and energy-efficient equipment, systems, and design solutions based on *life cycle* cost assessment (LCCA). See LCCA references in Tool for description of methodology and references to tools to help in developing the budget. See also AFEPPM 96-1 in reference to reducing imported oil dependence.
- A. 4. — Study potential for cost-effective use of photovoltaics, on-site wastewater treatment, and graywater systems (generally the potential for these is greatest in remote areas). Where those technologies show promise, include further studies as special requirements in the project description, and budget accordingly.
- A. 5. — Consider establishing a solar amount (SA) in the budget to fund passive and/or active solar strategies. SA will apply only to those features that prove to have a good savings-to-investment ratio based on LCCA during the design phase. Refer to ETL 94-4.
- A. 6. — Identify the funding sources for environmental items that cannot be addressed within the Programmed Amount (PA). If project is a renovation, consider use of MCP Energy Conservation Investment Program (ECIP) funds. See AFEPPM 96-4. Pollution Prevention (P2) funds may be available for some environmental initiatives which contribute to P2 goals.
- A. 7. — Budget for Full Systems Commissioning and for the preparation of O & M Manuals; include in approved DD Form 1391. See Commissioning Tool of this Guide for a discussion of commissioning and references.
- A. 8. — Optimize the size of the facility; provide for joint use of common spaces; seek opportunities to consolidate. For example, one way to consolidate is to use systems furniture.
- A. 9. — Reuse existing facilities on base as legally mandated instead of demolishing them. Of course, reusing historical facilities is the ultimate recycling. If reuse is not practical, plan for the salvaging of valuable materials and recycling of demolition waste to the greatest extent practical. See Building Reuse Chapter of this Guide for further information and references.

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A. 10. — Maximize flexibility by incorporating design elements that will make the facility and site more conducive to other functions in the future. Some examples include moveable modular casework and systems furniture.

A. 11. — In the process of performing the required economic analysis, the evaluation of building new, renovating or leasing facilities should be coordinated with the EIAP findings on the environmental impacts of each option.

ACTION ITEMS  
SITE

Rank the alternate sites for the proposed project based upon a comparative analysis of the following issues:

B. 1. — Review the Comprehensive Plan, particularly base general plan guidelines, or sub-area development plan recommendations to ensure optimal coordinated site selection with solution integrated into base layout.

B. 2. — Consider the potential environmental impacts the proposed improvements will have upon the surrounding environment, neighboring communities and cultural and natural resources. Pay particular attention to impacts on source water quality, increased storm water runoff, increased erosion potential, noise and ambient air quality. Ensure compliance with NEPA. Checklist items include:

Consider the reuse or rehabilitation of an existing previously developed site rather than altering undisturbed raw land.

Consider the location and functional relationship of the proposed site in relation to existing facilities to minimize transportation requirements and to provide opportunities for shared use of common areas, such as parking, wherever possible.

Understand the micro-climate of each site and identify which sites have the best potential for sustainable design based on temperature, humidity, wind and solar orientation. Also, consider each site's potential for producing alternative forms of electricity. For example, remote guard houses may be good candidates for the use of photovoltaics.

Consider the vegetation and topography of each site and identify which site would require the least amount of disruption in order to accommodate the proposed improvements.

Consider the geology and hydrology of each site. Avoid development of sites that would adversely affect watersheds. Also consider any potential for cleanup (Installation Restoration Program - IRP) requirements for the site.

Understand the ecology of the site and identify natural habitats that may be endangered through its development. Select a site on which the proposed improvements can be developed in a manner that maintains the existing ecological balance.

## INTRODUCTION

During the Pre-Contract phase the project is advertised for design services, the A/E firm is selected and a Statement of Work (SOW) developed. The Commerce Business Daily (CBD) announcement for design services may be modified to require sustainable design experience. See the A/E Selection Tool for an example. Federal Acquisition Regulation (FAR) Revision 5/31/95, 60 FR 28494, requires agencies to evaluate each potential contractor in terms of its “demonstrated success in prescribing the use of recovered materials and achieving waste reduction and energy efficiency in facility design.”

The pre-definition conference serves as a kick-off meeting for the design effort. This is a good time to define and assign sustainable design responsibilities within the project team.

Be sure that sustainable design objectives such as energy efficiency, resource conservation and indoor air quality are incorporated into the Requirements Document (RD) and the SOW and serve as criteria in the architect selection process. Convey sustainability requirements to the Design Agent (DA) (Corps of Engineers (COE) or Naval Facilities Engineering Command (NAVFAC)) as early as possible in the process.

- ..... Base Pollution Prevention Management Action Plan. (P2MAP).
- ..... ETL 90-10: Commissioning of Heating, Ventilating, and Air Conditioning (HVAC) Systems Guide Specification, 17 Oct 90.
- ..... ETL 94-8: Design in Metric, 14 Dec 94.
- ..... FAR Revision 5/31/95, 60 FR 28494 (FAR 36.602-1).
- ..... HQ ACC Sustainable Facility Statement of Work and A/E Selection Criteria, 1996.
- ..... Life Cycle Cost in Design (LCCID), [www.cecer.army.mil/facts/sheets/PL31.html](http://www.cecer.army.mil/facts/sheets/PL31.html)
- ..... National Bureau of Standards (NBS) Handbook 135, Life Cycle Costing Manual for the Federal Energy Management Program: a guide for evaluating the cost effectiveness of energy conservation and renewable energy projects
- ..... National Historic Preservation Act (NHPA) Section 106.
- ..... NEPA document developed in Planning Phase.
- ..... Sustainability Goals document developed in Planning Phase.
- ..... Storm Water Pollution Prevention and Management Plan.
- ..... USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.
- ..... USAF Project Manager's Guide for A/E Services Acquisition.
- ..... USAF Project Manager's Guide for Design and Construction.

- A. 1. — Create or complete an environmental permitting checklist.  
Review the permits identified in the EIAP or obtain a checklist from the base Environmental Flight or from the AF Regional Environmental Office. With the Environmental Flight, review the checklist against the project scope to determine what permits may be required. Integrate facility environmental design goals with the Environmental Assessment (EA) or Environmental Impact Statement (EIS) procedure for the project. The Installation Restoration Program (IRP) Manager and the Water Quality (WQ) Manager need to be involved for hazards, wells, mines and dump sites.
- ..... A. 2. — Request specific sustainable design expertise in the Commerce Business Daily advertisement. A possible description is: "experience in energy efficiency, resource efficiency, indoor air quality and *life cycle* costing." See the A/E Selection Tool for an example.

- A. 3. — Ask questions about the firm's experience with sustainable design issues such as energy efficiency, resource conservation and indoor air quality, at the A/E interview. See the A/E Selection Tool for ideas.
- A. 4. — Review and validate the Sustainable Facility section of the SOW at the Pre-Definition Conference. See SOW Tool for examples. Establish partnering program involving all project team members for goal setting and teaming.
- A. 5. — Develop preliminary list of construction materials which may be recycled, either as demolition material or construction waste, based on evaluation of available recycling infrastructure in your area. These may include such materials as: brick, concrete, metals, clean dimensional wood and land-clearing debris. Evaluate the feasibility of recycling additional materials such as engineered wood products, rigid foam insulation, glass, gypsum drywall, carpet and carpet padding, vinyl, etc.
- A. 6. — Based on local market potential, include recycling certain construction waste in the SOW. The actual requirements can be refined during design and contract document development phases.
- A. 7. — Clearly state the commissioning requirement at the Pre-Definition Conference. Establish documentation procedures for commissioning during design and construction.
- A. 8. — Inform the design team concerning unique features of the site that may affect budget or scope, such as wetlands, aquifer recharge zones or special cultural or archeological sites at the Pre-Definition Conference. Also review potential site hazards such as wells, mines or dump sites. All of these features and hazards are identified during the EIAP and/or the NHPA's Section 106 process.

INTRODUCTION

Requirements Analysis is an information-gathering phase that precedes the concept design effort (Project Definition Phase). During Requirements Analysis, establish project goals, verify programmatic requirements and evaluate the site. Collect information on climate and other project definition information that will support environmental goals during the design effort, such as locally manufactured products and native/site-adapted plants lists. Consider allocating space for program needs that can support both mission requirements and environmental goals, such as bicycle storage and waste recycling handling.

If a separate Requirements Analysis charrette is held, review and, if necessary refine, the Sustainability Goals document prepared in the Planning Phase.

Perform a preliminary cost-to-benefit analysis for items on the Sustainability Goals list that are not design-specific and that may impact cost. See Life Cycle Cost Analysis (LCCA) Reference Tool for description of methodology and references to tools.



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- ..... Base Pollution Prevention Management Action Plan (P2MAP).
- ..... Construction Criteria Base (CCB), most current release, for energy and utility conservation guidance.
- ..... Environmental Quality Protection Planning Bulletin/Manual, 1989.
- ..... ETL 90-10: Commissioning of Heating, Ventilating and Air Conditioning (HVAC) Systems Guide Specification, 17 Oct 90.
- ..... ETL 94-4: Energy Usage Criteria for Facilities in the Military Construction Program (MCP), 19 Aug 94.
- ..... ETL 94-7: EPA Guideline Items for Construction and Other Civil Engineering Specifications, 14 Dec 94.
- ..... Department of Defense (DOD) Energy Managers Handbook, Nov 96.
- ..... Department of Defense (DOD) Memo: EPA Guideline Items, 3 Jun 96.
- ..... Historic Materials Source Book for Air Force Facilities, Oct 96.
- ..... MILCON Coach. (software)
- ..... MIL-HDBK 1165: Military Handbook, Water Conservation.
- ..... PD Tutor. (software)
- ..... Secretary of Interior's Standards for Rehabilitation.
- ..... Sustainability Goals document (developed in Planning Phase).
- ..... USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.
- ..... USAF Guide to Buying Recycled, Jun 97.
- ..... USAF Project Manager's Guide for Project Definition.

ACTION ITEMS  
GENERAL

- A. 1. — If a separate Requirements Analysis charrette is held, develop consensus on and prioritize specific environmental goals for the project, such as water conservation, recycling, natural feature protection, site restoration, etc.
- A. 2. — Review the Base's Pollution Prevention (P2) Management Action Plan (MAP) and list opportunities within the project environmental goals that might assist in targeted Pollution Prevention goals in these areas:
  - ..... P2 Program Targets.
  - ..... Reduce or eliminate ozone depleting substances (see Ozone Layer Depleting Chemicals List on AFCEE website).

- ..... Reduce toxic chemical use: EPA-17 chemicals, pesticides (see The EPA-17 Target Chemical List and Typical Uses on AFCEE website).
- ..... Reduce Toxic Release Inventory (TRI) chemical releases and transfers (see Environmental Flight for current list of chemicals of concern).
- ..... Reduce amounts of hazardous and solid waste disposed.
- ..... Conserve energy and water.
- ..... Purchase recycled-content and other environmentally preferable products (see USAF Guide to Buying Recycled).
- A. 3. — Provide A/E with the following existing environmental studies if available: environmental baseline, Comprehensive Plan environmental tabs, special investigations, National Environmental Protection Agency (NEPA) documentation for the project and any other related environmental quality studies, including existing environmental, noise, air and water quality studies.
- A. 4. — Document occupancy requirements, design criteria, and define design conditions for use in commissioning documentation. See Project Commissioning Tool for a summary of the commissioning process and references.
- A. 5. — Evaluate need for any new air or water permits and/or requirements for facility emissions control devices, oil/water separators, sanitary storm drains, etc. Work with base pollution prevention specialists to see if opportunities exist to use pollution prevention to avoid design decisions which lead to environmental compliance liabilities. Specifically, design the project to avoid requirements for waste treatment, emission controls and environmental permits.

ACTION ITEMS  
SITE

- B. 1. — Produce a complete site survey and soils report. Include watersheds, drainage areas, stream corridors, wetlands, aquifer recharge zones, hundred year flood plains, special vegetative areas, habitats for endangered species and a tree survey (include location, genus and species) of all trees sized 15 cm DBH (diameter breast height) or greater. Identify locations of any special cultural or archaeological sites. Document all information on site analysis drawings.
- B. 2. — Test site radon levels if the region has potential for radon contamination.
- B. 3. — Develop a plant list to be utilized during the design process that identifies acceptable native plants and other plants that are suitable for use on the site based upon existing climate, soils and ecology.
- B. 4. — The Alternative Motor Fuels Act of 1988 (42 USC 6374) contains the requirement to explore potential for use of alternative fuel vehicles. Where appropriate, consider integration of recharge stations for electric vehicles into the site and/or facility.

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ACTION ITEMS  
WATER —  
CONSERVATION  
AND QUALITY

- B. 5. — Explore potential for utilizing bicycles as an alternative means of transportation. Where appropriate, provide bicycle racks to encourage their use, incorporating paths to serve the site. Showers and changing facilities may also be incorporated if justified.
- C. 1. — Minimize permanent irrigation systems by selecting plant materials that are appropriate for the site's climate and soils. If plant materials requiring supplemental water are desired, limit their use to a defined area and utilize efficient drip irrigation systems.
- C. 2. — Evaluate potential for rainwater retention or graywater recycling. The Life Cycle Cost Analysis Reference Tool may be used to show benefits which may accrue from including these systems in the project. Ideal applications are regions with limited water availability and where some landscape irrigation is desirable. Since graywater reclamation and wastewater treatment facilities require regulatory authority approval, initiate the permitting process as soon as the requirement is known. Identify the personnel who will operate and maintain the treatment system and obtain their input before selecting a system.
- C. 3. — Before building wastewater pre-treatment facilities, reduce or eliminate sources of industrial process wastewater discharged to wastewater system.
- C. 4. — Evaluate potential for cost-effective mechanical, biological, or physical/chemical on-site wastewater treatment for facility wastewater or runoff from paved areas. The Life Cycle Cost Analysis Reference Tool may be used to show benefits which may accrue from including these systems in the project. Ideal applications for wastewater include facilities with high water use requirements and localities where water treatment is limited and/or costly. Ensure that facility siting is in accordance with the wellhead protection plan of the base.
- C. 5. — Develop water conserving criteria for plumbing fixtures. At a minimum use low-flow fixtures as described in MIL-HDBK 1165. Consider more water-efficient options for lavatory faucets and shower heads.
- C. 6. — Evaluate requirements for National Pollution Discharge Elimination System (NPDES) storm water permitting, resulting from facility operations or construction.
- C. 7. — Develop and implement stormwater construction P2 and best management practices for facility and surrounding area to minimize potential for storm water runoff during construction and after construction is completed.

[NPDES]

National Pollution Discharge Elimination System



- D. 1. — Determine Energy Use Budget (EUB) based on USAF ETL 94-4. Based on facility type and geographic location determine budget for facility's total energy usage as well as the probable individual energy budgets for lighting, heating, cooling, plug loads and pumps and motors when there is opportunity to reduce energy usage based on system selection. This becomes the benchmark energy budget for the facility.
- D. 2. — Establish quantifiable energy consumption and renewable energy goals. EUB must be met at a minimum; develop goal based on preliminary analysis and professional opinion of the design team.
- D. 3. — Establish criteria for HVAC systems design soliciting input from CE maintenance shops. Consider Primary Heating Equipment based on the 97 1/2% design temperature values, with a target load safety factor of no more than 10%, and a *heating pick-up load factor* of less than 30%. Specify high energy efficiency equipment for all HVAC systems, domestic hot water, etc., which are not yet part of EPA Energy Star program.
- D. 4. — Gather information on the climate including temperature, humidity, *insolation*, wind, precipitation and other weather anomalies.
- D. 5. — Identify aspects of the micro-climate that create opportunities for energy conservation such as solar orientation for passive and/or active solar strategies, and topography or vegetation for shade and windbreaks. Document on-site analysis drawings.

## case study

In the Spring of 1995, as part of a DOD Legacy grant and the second phase of the Cool Communities project, American Forest strategically planted trees around 64 homes in the Palo Verde housing area at Davis-Monthan Air Force Base, with the purpose of reducing energy bills and lowering interior temperatures. Secondary benefits include reduced storm water runoff and improved air quality. The findings:

.....Energy savings are significant and will increase as trees grow.

Direct summer energy savings from trees, one year after planting, is valued at \$28 per home annually, and savings will increase to \$51 per home once the trees mature.

If all the residences on the base were planted similarly, energy savings to the base would total approximately \$35,000 annually one year after planting and would increase to about \$64,000 annually at maturity.

.....Peak storm water flow will be reduced to 32% at maturity.

This reduction is enough to avert the need for construction of 470 cubic meters (16,600 cubic feet) of storm water retention facility, at a cost of approximately \$7,500.

If tree canopy in all the residential areas on the base were increased to match the level at the study site (42% projected at maturity), the savings to the base in terms of avoided storm water retention facility construction would total approximately \$140,000.

..... Air quality will be improved by reducing airborne carbon.

The trees planted under this project will sequester approximately 2.27 metric tons (2.5 tons) of carbon annually at maturity, a function valued at approximately \$2,200. If all of the base’s residential neighborhoods were planted in this way, these trees would sequester approximately 40.8 metric tons (45 tons) of carbon annually, at a value of approximately \$42,000.

D. 6. — Explore energy sources available at the site. Identify opportunities for the cost-effective use of alternative energy resources such as photovoltaic panels, wind, and biofuels.

case study

On the British-owned Ascension Island, a 54.7 square-kilometer (34 square-mile) island in the South Atlantic, the U.S. Department of Defense installed their first wind farm. Four 30.48 meter (100 feet) tall wind turbines have a rated capacity of 1,000 kilowatts. To date, the wind farm is supplying between 20–25% of the air station’s electrical demand.

According to the AF project engineer, the three blade wind turbines will save almost 1,135,500 liters (300,000 gallons) of JP-8 diesel fuel annually that is shipped to the remote island. The equipment cost will be amortized in eight to nine years, after which the energy produced is basically free. The cost of the project was just over \$3 million.

D. 7. — Review utility rate structure; identify demand charges. Evaluate potential for utility rebates.

D. 8. — Determine lighting levels for all programmed areas based on Illumination Engineering Society (IES) recommendations. Consider lighting strategy when determining foot-candle levels (e.g., uplighting, downlighting, etc.) When task lighting is anticipated, reduce ambient lighting levels accordingly.

D. 9. — Determine plug loads for energy modeling purposes based on the probable usage. Consider difference between energy surge during equipment start up and actual energy usage of equipment, and factor in diversity to reflect actual number of equipment users at any given time. Plug loads are commonly overestimated.

D. 10. — Require office equipment and appliances to meet the requirements of the EPA Energy Star program.

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ACTION ITEMS  
INDOOR AIR QUALITY

- E. 1. — Adopt ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality (IAQ), as a design guideline.
- E. 2. — Document IAQ-related site characteristics. In urban, industrial or other areas with possible air quality problems, test ambient air quality on-site. Typical facility-related air pollutant emissions sources to be addressed include aircraft operations, motor vehicles, energy generators and boilers, incinerators, industrial processes (such as plating, spray-painting and abrasive blasting), volatile fuels and solvents, jet and rocket engine test facilities, asphalt/concrete plants, wastewater treatment facilities and bakeries and laundries.
- E. 3. — Determine filtration requirements. Consider requiring installation of alarm or sensor to notify facility maintenance of need to change filter so that excessive static pressure does not develop and compromise efficiency.
- E. 4. — Determine fresh air rates based on ASHRAE Standard 62-1989 recommended quantities of fresh air per person. Do not underestimate occupant densities; consider programmed number of occupants plus visitors and plan for possible future requirements.

ACTION ITEMS  
BUILDING MATERIALS

- F. 1. — Designer will specify a preference for recycled-content building materials in accordance with ETL 94-7 and the AF Guide to Buying Recycled. Preference will be given to specifying recycled/recycled-content EPA Guideline Items.
- F. 2. — Identify locally manufactured types of building materials and products, and create list of manufacturers/suppliers for design team. This will streamline the materials research process during the design phase, and will enhance early consideration of locally manufactured types of products; however, it will not be used to limit competition during bidding. At some installations it may be simpler to identify building materials and products that are not available locally.
- F. 3. — In historic facilities, identify building materials for renovation. They are subject to the Secretary of Interior's Standards. See Historic Materials Sourcebook for Air Force Facilities, Oct. 96, usually available in office of Cultural Resource Manager.

ACTION ITEMS  
WASTE MANAGEMENT

- G. 1. — Research local recycling infrastructure. Common recyclables generated on base include: white and mixed paper, cardboard, steel, aluminum, plastic and oil. To establish economic viability, research local recycling infrastructure, market value for each recyclable and minimum quantities for collection. Determine requirements for separation, baling, compacting and shredding for each type of recyclable.
- G. 2. — Establish and quantify operational waste recycling goals. Review locally mandated recycling requirements based on occupancy type.
- G. 3. — Allocate space for waste recycling and handling. Consider common operational recyclables listed above as well as food and yard waste composting.
- G. 4. — Review requirements for hazardous waste handling, such as oil, paint and medical waste, identified in the EIAP document.

ACTION ITEMS  
OPERATIONS AND  
MAINTENANCE

The design must take operations and maintenance into account. If the facility systems are too complex or too expensive to operate or maintain, the systems may quickly deteriorate, and potential energy savings and environmental benefits may never be realized. It is normally prudent to choose systems that are easy to operate, maintain and repair, within locally available or in-house capabilities. If analysis shows, however, that more training would enable use of a more sophisticated system that reduces overall cost, then the training and commissioning requirements should be expanded accordingly.

## INTRODUCTION

Project Definition (concept design) is most commonly accomplished in the MILCON program with the charrette process. Issues such as the placement of the facility on the site, massing, orientation and plan organization will be addressed, and all major building systems will be defined. Those schematic level decisions will set the direction of the design and determine, to a large extent, the ultimate success of the facility in terms of its sustainable design goals.

the charrette process, by its very nature as a collaborative, cross-disciplinary, hands-on work session, is excellent for this kind of investigation. It is essential that all participants understand the sustainable design goals for the project, as it will cause them to consider some of their responses differently. And it is important that the decisions made during the charrette session be followed up by analysis to determine whether the design meets the desired goals.

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- Base Architectural Compatibility Guidelines.
- BLAST, DOE-2, Energy-10, Lumen Micro (computer programs)
- Building for Tomorrow: Buy Recycled Guidebook for the Commercial Construction Industry, National Recycling Coalition.
- Sustainable Building Technical Manual: Green Building Design, Construction and Operations.
- USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.
- USAF Passive Solar Handbook, Volume I.
- USAF Project Manager’s Guide for Project Definition.
- USAF Project Manager’s Guide for Design and Construction.
- Also refer to Building Materials references listed in Chapter 9, Contract Document Development: Building Materials.

ACTION ITEMS  
GENERAL

- A. 1. — Use the charrette process to develop consensus on Sustainability Goals defined in Planning Phase. Outline detailed goals. Refer to Design Solution Documentation Tool.
- A. 2. — Design for flexibility to allow ease of future change and/or expansion. Identify potential future expansion areas even if expansion is not part of program requirements.
- A. 3. — At the close of the charrette, establish a schedule for design reviews. Obtain a commitment from the environmental and engineering team members to participate in these reviews to make sure the design adheres to the project’s Sustainability Goals.

ACTION ITEMS  
SITE

- B. 1. — Review site survey and soils report and site analysis drawings (from requirements analysis phase) at the outset of the charrette. If existing cultural resources or threatened and endangered species have been noted, work with base environmental specialists to develop an appropriate response.
- B. 2. — Minimize disturbance to existing vegetation and topography. Develop strategies for site development (e.g., location of facility and roadways) that work with the site’s existing drainage patterns to allow ground water recharge. Use tree survey to minimize impacts on existing vegetation.

- B. 3. — Minimize disturbance to existing hydrological features. Keep construction, underground site utilities, heavy vegetation, roadways and other infrastructure away from stream channels, flood plains and wetlands.
- B. 4. — Consider impact of the design on water flows on the site. Where natural features on the site are not sufficient to absorb all storm water through infiltration (e.g. limited open space, soils that limit percolation), develop on-site storm water retention and detention strategies to minimize reliance on storm water systems.
- B. 5. — Minimize impervious cover on the site. Avoid large expansive parking areas; they can create concentrations of contaminated runoff, reduce infiltration, create “heat islands,” and are aesthetically unpleasant. Where possible use pervious materials in low traffic areas, such as pedestrian pathways and overflow parking.

ACTION ITEMS  
WATER CONSERVATION  
AND QUALITY

- C. 1. — Group similar water-using functions whenever possible. Domestic water use will benefit from decreased pumping requirements. If recycling of graywater or rainwater catchment has been identified as a goal, careful grouping of water-using functions, such as golf courses and car washes, reduces consumption of treated domestic water sources and eases collection, treatment and reuse.
- C. 2. — Limit reliance on irrigation. If permanent irrigation is required, limit its use to a defined area. Identify irrigation zone clearly on the site plan drawings. Justify the need for irrigation in the charrette report.

ACTION ITEMS  
ENERGY

- D. 1. — Review passive solar priorities, goals for use of renewable energy technologies, and review the micro-climate of the site. Identify preferred facility orientation to maximize positive effects of solar and wind.
- D. 2. — Develop *base case building* scheme prior to the charrette for use as a point of comparison. Base case shall meet the USAF Energy Use Budget (EUB) and local codes. Model base case scheme prior to charrette, and test alternate schemes proposed during the charrette with the energy model. Energy modeling shall be done using DOE-2, or BLAST for larger multi-zone projects and Energy-10 for projects under 929 SM (10,000 SF).
- D. 3. — Evaluate potential for passive solar load reduction based on whole facility energy performance and passive solar and climate-responsive strategies. See USAF Passive Solar Handbook, Volume I for a description of the following passive solar strategies: daylighting, passive solar heating and cooling and natural ventilation.

D. 4. — Evaluate potential for use of renewable energy such as photovoltaics, geothermal, wind and solar using Life Cycle Cost Analysis (LCCA). See LCCA Reference Tool.

D. 5. — Maximize productive use of daylight. Evaluate toplighting and sidelighting strategies. Where possible, locate program areas that benefit most from daylight at perimeter zones with northern and southern exposures (northern is preferred in hot climates, southern in cold climates). Eastern and western exposures require more careful sun control strategies.

D. 6. — Perform daylighting studies where preliminary analysis shows that daylighting may be an effective strategy for energy conservation. Determine the effective depth of the “daylit zone.” Lumen Micro, the computer daylighting model, is an effective and efficient tool for quantifying daylight. The use of scale models may be preferred for especially complex spaces and for a qualitative evaluation of the daylighting scheme.

D. 7. — After the charrette, perform LCCA to assess the value of energy saving features that add to the initial cost. Features such as passive solar strategies, automated lighting controls, task lighting, energy management and control systems, etc., should be studied to determine whether they are cost-effective and should remain in the design. See Tool for a description of LCCA and references.

D. 8. — Energy features with high first costs, such as photovoltaics and active solar strategies, should be reserved for appropriate geographic locations or unique project conditions that warrant their consideration.

ACTION ITEMS  
INDOOR AIR QUALITY

E. 1. — Locate air intake and exhaust. Analyze air flow into, through, and out of the facility. Consider prevailing winds and minimize potential for cross circuiting of intake and exhaust air.

E. 2. — Isolate pollutant-generating activities (such as food preparation areas, print shops, laboratories, loading docks) from general use occupied areas.

E. 3. — Review Chapter 13 of the Sustainable Building Technical Manual for additional discussion of design approaches to improve indoor air quality.

ACTION ITEMS  
BUILDING MATERIALS

F. 1. — Minimize material expenses where possible. Avoid the use of finish materials where not necessary for performance or aesthetics. For example, maintenance areas generally require no finishes.



F. 2. — Review Environmentally Preferable Building Materials Tool and local products and materials list (from Requirements Analysis Phase) to make informed decisions about basic building systems. Also consult recycled content building material information sources and determine by Construction Specifications Institute (CSI) format which materials will be specified with recycled-content.

F. 3. — All hazardous materials brought on base must be approved by the base Hazardous Material Pharmacy or similar Hazardous Material Management (HMM) function.

ACTION ITEMS  
WASTE MANAGEMENT

Develop floor plans to aid collection of recyclables. Program areas that generate large quantities of recyclable waste (such as copy rooms and galleys) should be zoned together and located near vertical circulation to aid collection.

## INTRODUCTION

During Contract Document Development, each element of the final project is considered in light of the documents and materials previously developed.

Site analysis documentation developed during the Requirements Analysis and Project Definition phases remains useful for decision making as the facility location is finalized, grading defined and the planting and hardscape schemes developed.

## Planting plans should feature low-maintenance plant materials

that are well adapted to existing climate, soils and water availability. If necessary, site and landscape design can contribute to noise abatement. It also can minimize storm water runoff and pretreat runoff where necessary. Finally, the specifications provide many opportunities to describe procedures that will aid resource conservation and limit damage to the site during construction.



REFERENCE DOCUMENTS	<p>Base Landscape Plan.</p> <p>Base Natural Resource Management Plan.</p> <p>USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.</p> <p>USAF Guide to Buying Recycled, Jun 97.</p> <p>USAF Landscape Design Guide.</p>
ACTION ITEMS MINIMUM DISRUPTION OF SITE	<p>Minimizing disturbance to the site preserves trees, ecosystems, habitats, cultural resources and natural drainage patterns.</p> <p>A. 1. — Work with the existing topography. Design facility, parking and roadways to “fit” existing site contours and limit cut and fill. Avoid cultural resource sites, particularly archeological sites.</p> <p>A. 2. — Coordinate design of infrastructure (underground utilities, fire lanes, etc.) with facility location and site design so as to minimize disturbance of the site.</p>
ACTION ITEMS EXISTING SITE FEATURES	<p>Through consideration and protection of special site features, environmental damage to valuable natural resources can be limited.</p> <p>B. 1. — Protect existing hydrological features such as stream corridors, wetlands and aquifer recharge zones. Restrict development within the 100 year flood plain and special vegetative areas, such as those indicating the presence of wetlands or critical species’ habitats.</p> <p>B. 2. — Work with Base Environmental Specialists to develop appropriate response on sites that have threatened and endangered species, or special cultural resources.</p> <p>B. 3. — Develop erosion control plan. Comply with state ordinances at a minimum. Identify all potential erosion hazard zones and protect existing vegetation within those zones.</p> <p>B. 4. — Minimize impacts to existing vegetation. Clearly identify limits of disturbance and identify tree protection zones in the contract documents.</p> <p>B. 5. — Comply with all mitigation actions identified in the project’s Environmental Assessment (EA) or Environmental Impact Statement (EIS).</p> <p>B. 6. — Assure construction contracts have language to meet stormwater permit requirements. All actions or pre/post construction measures must be completed before final facility acceptance by COE or NAVFAC.</p>

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ACTION ITEMS  
LOW MAINTENANCE  
LANDSCAPING

- Implement *Xeriscape* concepts. Native and adaptive plantings tolerant of existing conditions reduce water, fertilizer and pesticide use, thereby conserving water and decreasing contamination of site runoff and ground water.
- C. 1. — Refer to plant lists of preferred plants for the area. Refer to local ordinances and Base Landscape Plan, if available. Base Planning (Comprehensive Plan, Environmental Flight or Facilities Excellence Plan) should have a list as well. Also contact Natural Resources Conservation Service, County Extension Agent or urban forester.
- C. 2. — Replace areas proposed for irrigated turf with native and naturalized shrubs, ground covers and grasses with water requirements that are appropriate to the region.
- C. 3. — If water-intensive plantings are desired, limit them to defined areas, and use rainwater catchment or recycled graywater to provide required water for irrigation, if possible.
- C. 4. — Provide drip irrigation or bubbler systems where permanent irrigation systems are necessary for planting beds; do not use high-pressure misting sprinklers. Equip irrigation system with rain sensor overrides.
- C. 5. — Provide temporary irrigation system for plants during their establishment period and in case of extreme drought.
- C. 6. — Submeter large irrigation systems that use potable water.

ACTION ITEMS  
NOISE ABATEMENT

- Strategies for noise abatement vary depending on whether the source is a point source or a non-point source.
- D. 1. — Develop acoustic strategy for noisy sites. If development is required within noise zones greater than 65 decibels Day/Night Average Level (DNL) depending on land use; provide additional building insulation, extra layer of glazing and/or white noise generators.
- D. 2. — Provide berms or walls to decrease noise impacts where point sources can be identified for noise.
- D. 3. — Carefully site all high-noise generators so that sound is dissipated as efficiently as possible. For example, locate high-capacity cooling towers so that noise from blowers will not adversely impact the facility or others.

ACTION ITEMS  
INDOOR AIR QUALITY

Limit occupant exposure to chemical and biological concentrations.

E. 1. — Use landscaping to buffer facilities from on-site and off-site sources of pollution. Verify that facility setbacks are adequate to prevent vehicle emissions from entering the facility.

E. 2. — Avoid the use of sporulating plants (i.e., plants that shed spores which are irritating to people with allergies) or plantings that may require use of chemical treatments, especially near facility openings such as air intakes, entries or operable windows.

ACTION ITEMS  
CONSTRUCTION  
METHODS

Construction methods that protect the site and reuse on-site materials must be clearly described in the project specifications. See further discussion in the Environmentally Preferable Building Materials Tool.

F. 1. — Limit duration of exposure of soil areas by careful scheduling.

F. 2. — Create composting facility for processing green waste into landscape resource.

F. 3. — Specify reuse of on-site materials to the greatest extent possible. Shred wood for use as mulch and crush rock for gravel if quantities required justify the cost. Stockpile existing topsoil for reuse on site.

F. 4. — Write in specifications to require spill prevention and response plan for on-site operations.

F. 5. — Specify park and landscaping products according to EPA Comprehensive Procurement Guidelines for recycled-content where applicable.

## INTRODUCTION

Water quality and water conservation can be achieved through careful attention to site design and site infrastructure, selection of landscape plantings and specification of efficient plumbing fixtures and HVAC equipment. Water quality and conservation strategies minimize environmental impacts due to transport and treatment of potable water, reduce requirements for environmental permits, eliminate contamination of water bodies due to spills and improper discharges by treatment facilities and increase recharge of ground water.



REFERENCE  
DOCUMENTS

- AFI 32-7041, Water Quality Compliance.
- Base Storm Water (P2) Management Action Plan.
- Construction Criteria Base (CCB), most current release, for energy and utility conservation guidance.
- EPACT
- MIL HDBK-1165; Military Handbook, Water Conservation.
- National Pollutant Discharge Elimination System (NPDES) Permits.
- USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.
- USAF Landscape Design Guide.

ACTION ITEMS  
WATER QUALITY

- Federal regulations mandate management of point source and non-point source pollution with NPDES (National Pollutant Discharge Elimination System) permits, a requirement of the Clean Water Act. Non-point source pollution includes sediment runoff, chemical runoff from landscape maintenance practices and oil and sediment runoff from roadways and parking areas.
- A. 1. — Oil/water separators should not be considered for industrial facility parking lots or storm water runoff. Isolated spills should be captured through alternative means such as absorbent pads.
  - A. 2. — Consider curbed parking areas with inlets that can be plugged in case of a large petroleum spill. If underground storm drains are present, consider a device to close the inlets.
  - A. 3. — Protect against possible spills or leaks. Cover and protect hazardous material storage areas so spills and leaks are not discharged to storm water systems.
  - A. 4. — Select native or well adapted species for landscaping together with Integrated Pest Management practices to minimize the need for fertilizers, herbicides and pesticides.
  - A. 5. — Develop and implement P2 and best management practices to reduce or eliminate stormwater runoff associated with industrial activities.

ACTION ITEMS  
INFILTRATION OF  
STORM WATER

- Infiltration is the ideal method of storm water management. Site soils and vegetation filter and cleanse storm water; ground water is replenished; and flooding and erosion is minimized. Where intense land development demands prohibit the use of on-grade systems, constructed subsurface infiltration basins can be used.

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- B. 1. — Work with natural drainage systems. Ideally, rate of runoff and quantity of water leaving the site after construction should be no more than the rates prior to construction.
- B. 2. — Consider alternatives to the use of curb and gutter. Use open vegetated swales for infiltration where space permits. Open drainage increases vegetative variety, reduces drainage velocity and erosion, supports wildlife habitat and requires little single-purpose maintenance.
- B. 3. — Use constructed water retention and detention and/or filtration systems where space is limited and swales are not practical for storm water collected from curb and gutter.
- B. 4. — Minimize paved surface area for vehicles and pedestrians through efficient design of roadways, parking areas and pedestrian areas.
- B. 5. — Minimize the use of impervious paving materials. Use permeable materials such as porous asphalt, porous concrete, open-celled pavers or stabilized aggregate. Use impervious materials only in high traffic areas or in places with unstable soils or steep slopes.

ACTION ITEMS  
ON-SITE WASTE  
WATER TREATMENT

Where preliminary planning assessments show that on-site wastewater treatment may be cost-effective, the design team will develop a scheme and detailed LCCA analysis for final review.

C. 1. — Develop constructed wetlands scheme and detailed LCCA for wastewater treatment when preliminary planning assessments show it to be cost-effective. Identify pollutants to be removed from the water, detention time necessary for thorough treatment, the area necessary to meet habitat requirements of desired vegetation, aquatic life survival requirements, and aesthetics. When man-made wetlands are required, site them to avoid Bird Air Strike Hazard (BASH) issues.

C. 2. — Develop graywater scheme and detailed LCCA where preliminary planning assessments show it to be cost-effective.

ACTION ITEMS  
WATER CONSERVING  
PLUMBING FIXTURES

The Energy Policy Act of 1992 (EPACT) mandates the use of low-flow plumbing fixtures. Some local codes have water use limits that are more restrictive than EPACT. Automated controls and alternative fixtures such as composting toilets and waterless urinals can further reduce water use and sewage treatment costs.

D. 1. — Toilets: EPACT requires low-flow toilets, with a maximum rate of 6.056 liters per flush (LPF) (1.6 gallons per flush (GPF)). Verify sewer lines have sufficient fall to provide adequate scarifying velocity to avoid buildup of solids.

D. 2. — Urinals: EPACT requires low-flow urinals with a maximum rate of .94625 liters per cycle (1.0 GPF).



D. 3. — Lavatory Faucets: EPACT limit for lavatory faucets and replacements and aerators is 9.46 liters per minute (2.5 gallons per minute (GPM)). Consider using faucets for lavatories with flow restrictors for a maximum rate of 1.89 LPM (.5 GPM), or use metering faucets at .95 liters per cycle (0.25 gallons per cycle).

D. 4. — Consider alternatives to traditional faucets for water conservation, such as infrared sensor faucets, delayed action shut-off or automatic mechanical shut-off valves.

D. 5. — Kitchen Faucets: Use low-flow faucets for kitchen faucets with a maximum rate of 9.4625 liters per minute (LPM) (2.5 gallons per minute (GPM)).

D. 6. — Shower heads: EPACT requires low-flow shower heads with a maximum flow rate of 9.4625 liters per minute (LPM) (2.5 gallons per minute (GPM)). Consider lower LPM (GPM) ratings; some states allow 7.5 LPM (2 GPM).

D. 7. — Domestic Dishwashers: 37.85 liters (10 gallons) a cycle or less. Commercial Dishwashers (conveyor): 454.2 liters per hour (120 gallons per hour).

D. 8. — Consider the use of waterless urinals, especially in regions with limited water availability. Waterless urinals are odor free, and are installed to a typical drain line. A small quantity of “blue seal” liquid isolates urine from room atmosphere and is recharged periodically (every 1500 uses). Verify compliance with local codes.

D. 9. — Consider the use of composting toilets in remote locations. Composting toilets are either self-contained units, or have separate, remote storage tanks. Composting toilets should be National Science Foundation (NSF) approved.

ACTION ITEMS  
WATER CONSERVING  
HVAC EQUIPMENT

Environmental impacts due to water-consuming HVAC equipment are compounded by the fact that units generally use potable water and consume energy for pumping and wastewater requires treatment.

E. 1. — Avoid the use of “one-pass” cooling units that transfer heat to potable water and discharge it to a drain.

E. 2. — Minimize blowdown for cooling towers through the use of industrial water treatment programs. To manage water usage for the cooling tower, provide metering for both the make-up and the blowdown water.

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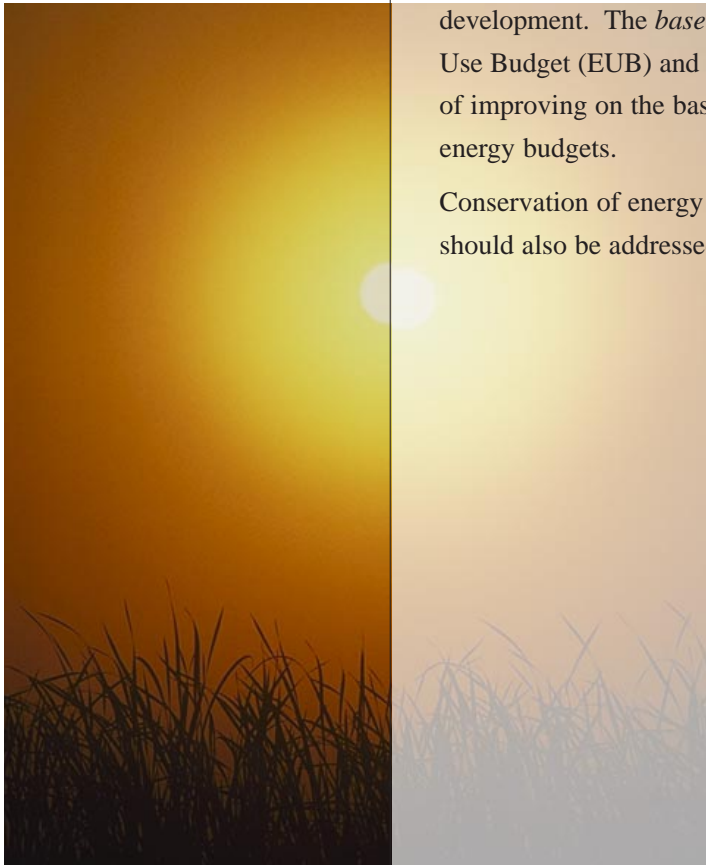
## INTRODUCTION

Successful energy-efficient design requires a high degree of coordination and collaboration among engineers, architects and interior designers. Passive solar and daylighting strategies are integrally imbedded in architectural form and interface with interior space planning strategies.

The topics outlined in Chapter 8 follow the hierarchy presented in the US Air Force Engineering Technical Letter (ETL) 94-4. The issues are meant to be addressed in the order in which they appear. This will, for example, reinforce the importance of exploring all strategies that reduce loads first, before selection and design of mechanical systems.

Energy Modeling is an essential tool for improving performance and evaluating many complex variables. The benchmark energy budget and base case design from the design charrette are meant to serve as a comparison point during design development. The *base case building* design is one that meets the USAF Energy Use Budget (EUB) and all codes. The design team should take on the challenge of improving on the base case design and exceeding all performance targets and energy budgets.

Conservation of energy in historic buildings presents special challenges that should also be addressed by the design team.



- ..... AFCESA A-Gram: How To Select Energy-Efficient Electric Motors, Apr 96.
- ..... AFEPPM 96-1: Air Force Energy Management Plan, 1 Jun 96.
- ..... AFEPPM 96-2: Air Force Water Management Plan, 1 Jun 96.
- ..... Air Staff's Memo, 21 Oct 94, "Oil/Water Separator/s Operation, Maintenance and Construction".
- ..... ASHRAE 1-1989: Guideline for Commissioning of HVAC Systems, [www.ashrae.org/text.htm](http://www.ashrae.org/text.htm)
- ..... ASHRAE 55-1992: Thermal Environmental Conditions for Human Occupancy.
- ..... ASHRAE 62-1989: Ventilation for Acceptable Indoor Air Quality.
- ..... ASHRAE 90.1-1989: Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.
- ..... Building Loads Analysis and Systems Thermodynamics (BLAST), energy computer model.
- ..... 10 Code of Federal Regulations (CFR) 435: Performance Standards for New Commercial & Multifamily High-Rise Residential Buildings (compliance required by 1992 Energy Policy Act - Public Law 108-482).
- ..... "Conserving Energy in Historic Buildings" by Baird M. Smith; Preservation Brief developed by National Park Service Preservation Assistance Division, US Govt. Printing Office, Washington, DC 20402.
- ..... Construction Criteria Base (CCB), most current release, for energy and utility conservation guidance.
- ..... DOE-2: <http://eande.lbl.gov/BTP/DOE2.html>
- ..... EPA Energy Star Program, Equipment and Buildings: <http://es.inel.gov/partners/estar/estar.html>
- ..... ETL 83-9: Insulation, 14 Nov 83.
- ..... ETL 86-16: Direct Digital Control Heating, Ventilation, and Air Conditioning Systems, 9 Dec 86.
- ..... ETL 94-2, Utility Meters in New and Renovated Facilities, 10 Jun 94.
- ..... ETL 94-4: Energy Usage Criteria for Facilities in the Military Construction Program (MCP), 19 Aug 94.
- ..... ETL 95-4: Mandatory Energy/Water Performance Standards for Replaced or Modified Equipment, 31 Oct 95.
- ..... Executive Order 12902: Energy Efficiency and Water Conservation at Federal Facilities, 8 Mar 94.
- ..... Federal Lighting Energy Expert (FLEX) 3.0 Lighting Software (from FEMP Help Desk, 800-363-3732 or [www.eren.doe.gov/femp/techasst.html](http://www.eren.doe.gov/femp/techasst.html)).
- ..... Illuminating Engineering Society (IES) Handbook.
- ..... Lumen Micro, daylight modeling computer program: [www.lighting-technologies.com/software.htm](http://www.lighting-technologies.com/software.htm)

REFERENCE  
DOCUMENTS  
CONT'D.

- USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.
- USAF Design Guide for Military Family Housing Energy-Efficient Revitalization and New Construction, Jul 96.
- USAF Passive Solar Handbook, Volumes I, II and III.
- Visual DOE™, computer model: [www.eley.com](http://www.eley.com)

ACTION ITEMS  
ENERGY ANALYSIS

- A. 1. — Separate design sizing function from energy analysis function. Review inputs into energy model carefully, and develop diversity factors to reflect actual usage patterns.
- A. 2. — Categorize energy strategies that affect energy loads, energy use, energy cost and demand cost, and consider them separately.
- A. 3. — Give priority to energy strategies addressing largest annual energy cost component — lighting, cooling, heating or process load. (See ETL 94-4 for information on facility type and weather regions).
- A. 4. — Use BLAST or DOE-2 for computerized energy model to compare design options and system selections.

ACTION ITEMS  
BUILDING ENVELOPE/  
ORIENTATION

Maximize passive solar benefits based on passive strategies identified in Requirements Analysis and Project Definition phases. Thermal comfort can be enhanced through careful design of the facility envelope to limit radiant heating and cooling, drafts and temperature gradients. In addition, the facility envelope should be developed to enhance occupant comfort and minimize potential for mold and microbial growth.

consider natural ventilation

- B. 1. — Consider natural ventilation using operable windows with screens in moderate climates for facilities not overly sensitive to drafts or security requirements. Explore use of ventilated window frames in other instances. Air inlet openings must face in the direction of prevailing winds during the mild months of the year. Identify high and low pressure zones on the facility and site to locate ventilation features. Also consider the use of ceiling fans.
- B. 2. — Optimize facility glazing. Evaluate *U-value*, visible light transmittance and shading coefficient of the glass. Give preference to glass with a Coolness Index (CI - ratio of visible light transmittance to shading coefficient) greater than 1.2. In cold locations consider use of “super windows” with an *R-value* as high as 12. Consider impact of orientation and exterior and interior sun shading on performance of glazing.
- B. 3. — Incorporate exterior shading and sun control through the use of horizontal and/or vertical projections, sunscreens, shutters or trellises. Give priority to exterior sun control over interior strategies to control both light and heat gain. Coordinate with interior shading requirements and daylighting strategy.

solar benefits

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B. 4. — When using solar design, take care not to impact thermal comfort. Provide adequate insulation and sun control to minimize discomfort due to radiant heat gains and losses.

B. 5. — Evaluate impact of interior sunshading. Interior shading devices are an effective means of control for minimizing glare and improving comfort in the perimeter zone. They include insulating shutters, opaque and semi-opaque shades, film shades, draperies and venetian blinds. Consider facility orientation and coordinate with daylight strategy. Consider motorized blinds on photocell controllers in areas where individual control is not desired.

insulation

B. 6. — Optimize insulation. Evaluate benefit of heat retention vs. heat rejection based on results of energy modeling and determine most cost-effective quantity of insulation for roof, walls and slab.

thermal mass

B. 7. — Consider impact of thermal lag associated with heavy mass construction. Thermal mass saves energy in regions where the outdoor air temperature fluctuates daily above and below the comfort range, and can also save money in hot climates by reducing electricity use during peak periods. Thermal mass can also act as a heat sink for direct or indirect passive solar heating strategies. Base HVAC calculations on the ASHRAE Transfer Function Method.

B. 8. — Consider roofing color. Light colors reflect light and heat, reducing cooling requirements and diminishing the facility’s contribution to heat islands. Dark colors absorb heat and may be appropriate in cold climates. Coordinate with architectural compatibility standards for color and base airfield criteria.

B. 9. — Consider kinetic response of the facility envelope. Envelope components that have been developed to respond dynamically to changing climatic conditions include motorized shades for walls, windows or skylights, movable shutters or insulation and mirror systems that adjust to optimize the collection of daylight.

B. 10. — Minimize *thermal bridging*; detail carefully to avoid “cold spots” which cause discomfort and can lead to condensation on the cold surfaces. Condensation can lead to mold and to microbial growth, even though the relative humidity of the room air may remain within the range prescribed by ASHRAE 55-1992.

B. 11. — Provide adequate air barrier and vapor retarder to control air and moisture flow through the exterior wall. Correct placement of vapor barrier (at point where cool surfaces meet warm, moist air) and design of a tight exterior wall are major contributing factors in the prevention of microbial contamination.

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ACTION ITEMS  
LIGHTING AND  
DAYLIGHTING

[LCCA]  
lighting strategy  
daylit zones

Maximize natural light using a holistic approach that addresses artificial lighting requirements and heat gain.

- C. 1. — Review lighting requirements for all program areas (based on IES standards) that were developed during requirements analysis.
- C. 2. — Develop lighting strategy for each space type based on the use of the space and the quality of lighting desired (direct, indirect, task, combination). Maximize the use of borrowed light for interior areas.
- C. 3. — Study daylit zones of the facility. The design of the facility envelope, the quantity and type of glazing, the inclusion of sunshading and/or lightshelves, and the layout of interior partitions will influence how far light will penetrate into the facility interior. It can vary from 4.56 to 13.68 meters (15 to 45 feet). A daylight modeling computer program like Lumen Micro is an effective and efficient tool for quantifying daylight. The use of scale models may be preferred for especially complex spaces, and for a qualitative evaluation of the daylighting scheme.
- C. 4. — Use high-efficiency electric lighting with high-efficiency lamps and ballasts to supplement daylighting. Compare the efficacy of fixture options in terms of lux (lumen) output per watt of energy consumed.
- C. 5. — Develop lighting control strategy. Use LCCA to evaluate options, such as daylight dimming (continuous or stepped), occupancy sensors or time clock controls.
- C. 6. — Coordinate selection of lighting controls with selection of lamps and ballasts.

case study

In 1996, the Base Energy Manager at Randolph Air Force Base near San Antonio, Texas, completed a three-stage base-wide lighting retrofit. Through the Energy Savings Performance Contract (ESPC) program, a partnership was formed with the controls manufacturer to install and finance the cost of the new equipment, approximately \$1.8 million.

Over 57,100 32-watt T8 fluorescent lamps and 24,000 electronic ballasts were installed in offices. At hangars, shops, gymnasiums and warehouses metal halide lamps and fixtures were installed replacing high-maintenance older fixtures that also provided inadequate lighting.

The Air Force expects to save about half a million dollars a year in energy costs at Randolph alone. HQ AFCEA is developing six regional ESPC contracts that will provide opportunities for all Air Force Continental U.S. (CONUS) and Alaskan installations.

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ACTION ITEMS  
AUXILIARY SYSTEMS  
AND EQUIPMENT

- D. 1. — Consider technology-forcing specifications in accordance with Executive Order 12902 - Energy Efficiency and Water Conservation at Federal Facilities (Section 507(a)(2): upper 25% of efficiency or at least 10% more efficient than minimum federal standard level). ETL 95-4 gives even more specific guidance: Mandatory Energy/Water Performance Standards for Replaced or Modified Equipment.
- D. 2. — Use premium-efficiency motors for all motors over one horsepower and those expected to operate long hours.
- D. 3. — Use high-efficiency office equipment; look for the EPA Energy Star rating.

ACTION ITEMS  
ELECTRIC POWER  
AND DISTRIBUTION

- E. 1. — Incorporate tenant submetering, where practicable.
- E. 2. — Size transformers and generating units as close to the actual anticipated load as possible.
- E. 3. — Distribute electric power at the highest practical voltage and load at the maximum power factor and minimum THD harmonics consistent with safety.

ACTION ITEMS  
HVAC SYSTEMS  
AND EQUIPMENT

- Proper zone control of mechanical systems will enhance thermal comfort. Commissioning is required so that proper performance of designed systems can be ensured. Also ensure that training of operations personnel is included in specifications.
- F. 1. — Select HVAC systems and equipment based on LCCA of all feasible system alternatives. The final analysis of mechanical system alternatives shall take into consideration the proposed facility construction features which have been selected from previous analysis.
- F. 2. — The following systems shall be considered and evaluated using LCCA. See LCCA references in Life Cycle Cost Analysis Reference Tool to provide documentation for system acceptance or rejection:
- ..... Airside economizer;
  - ..... Waterside economizer; and
  - ..... Heat recovery for cooling and heating cycles.
- F. 3. — For LCCA analysis which is inconclusive, (i.e., the present worth of two or more alternatives varies by less than 5%), the system selection should be based on minimum annual energy consumption.
- F. 4. — Eliminate or reduce the amount of reheating or mixing of conditioned air streams for comfort control. All fans and air distribution systems should utilize temperature reset controls.
- F. 5. — Use variable frequency drives for pumps and fans and variable air volume boxes for air distribution, unless the design analysis clearly demonstrates that other equipment is more *life cycle* cost-effective.



F. 6. — Use energy-efficient pumps and motors. Refer to AFCESA /A-Gram: How To Select Energy-Efficient Electric Motors, Apr 96. Specify pre-occupancy baseline IAQ testing at time of commissioning. Test for indoor air concentrations of CO, CO<sub>2</sub>, total VOCs and particulates.

case study

Edwards Air Force Base received an Energy Conservation Incentive Award of \$80,000 in 1993, as part of the Design for Excellence program instituted by Southern California Edison Power Company. The award was attributed to the specification, procurement and installation of high-efficiency motors on pumps, blowers and mixers throughout the plant. Variable-frequency drive motors were also installed and contributed in the credit calculation.

F. 7. — Require contractor to provide a comprehensive Operations and Maintenance Manual for the facility. The manual should include operating instructions, the performance verification procedures and results, equipment inventory and the recommended maintenance program.

F. 8. — Ensure thermal comfort. Provide humidification and/or dehumidification as necessary. Consider the need for adequate air movement within areas served by Variable Air Volume (VAV) systems.

F. 9. — Locate facility openings and air intakes (including operable windows) away from potential pollutants/contaminants such as loading docks, standing water, cooling towers, sanitary vents, facility exhausts, vehicle exhausts, generator exhausts, parking garages and street traffic.

ACTION ITEMS  
SERVICE HOT WATER

G. 1. — Consider solar hot water system and heat recovery. Obtain MAJCOM energy coordinator's approval for all active solar applications.

G. 2. — Use low-temperature water heating systems. Systems should have temperature controls capable of being reset down to 34.8°C (90°F), or 46.8°C (110°F) for housing facilities. Food service operations shall have separate water heating facilities.

G. 3. — Hot water systems shall be fully insulated. Recirculating systems should have pumps with automatic control to cycle pumps off during hours of non-use.

ACTION ITEMS  
ENERGY MANAGEMENT  
SYSTEMS

Energy sensors may be integrated into the Energy Management and Control System (EMCS) where cost-effective.

case study

Randolph Air Force Base and the energy office use a fiber optic network and a computer system that controls air conditioning chillers and pumps around the base. It shuts down the systems that are not needed at night and weekends. The computer can also detect when something is wrong with a chiller or pump. Many times workers are on the site fixing the situation long before it becomes a problem or is even noticed by the occupants.

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## INTRODUCTION

Environmentally preferable building materials lessen impacts on the natural environment and indoor air quality throughout their *life cycle*. Content of the materials, the environmental impacts relating to the production process, energy required for transportation, impacts relating to ongoing maintenance procedures, *life cycle* costs, longevity and ultimate disposal or reuse of the materials are some of the issues to consider.

Look for inherent maintainability. For example, materials with integral finish that do not require applied finish after installation often conserve resources. 'Green' materials with short life expectancy are of little value.

Of course, when working on historic facilities, building material selection may require special considerations; i.e., materials which match the originals.

See the Environmentally Preferable Building Materials Tool for specific recommendations for material selection and specification.



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- ..... AIA Environmental Resource Guide, John Wiley & Sons, Inc.
- ..... ANSI 208.1-1993 and ANSI 208.2-1994: Limits on Formaldehyde in Fiberboard and Particleboard.
- ..... Base Architectural Compatibility Guidelines.
- ..... Environmental By Design, 1993.
- ..... EPA Report 530-B-95-004: Construction Products Containing Recovered Materials.
- ..... EPA Fact Sheet, EPA 530-F-96-020, Oct 96: 1996 Buy-Recycled Series, Construction Products
- ..... ETL 87-1: Lead Ban Requirements of Drinking Water, 15 Jan 87.
- ..... ETL 94-3: Air Force Carpet Standard, 10 Jun 94.
- ..... ETL 94-7: EPA Guideline Items for Construction and Other Civil Engineering Specifications, 14 Dec 94.
- ..... Federal Acquisition Regulation (FAR) 52.223-8: Estimate of Percentage of Recovered Material for EPA Designated Items to be Used in the Performance of the Contract.
- ..... FAR 52.223-9: Certification and Estimate of Percentage of Recovered Material Content for EPA Designated Items.
- ..... Good Wood List:  
..... [www.goodwood.org/goodwood/goodwood\\_list/goodwood\\_list.html](http://www.goodwood.org/goodwood/goodwood_list/goodwood_list.html)
- ..... GreenSpec: Guideline Specifications for Environmentally Considered Building Materials and Construction Methods.
- ..... Harris Directory, BJ Harris, 508 Jose Street #913, Santa Fe, NM; 505-995-0337.
- ..... National Park Service Sustainable Design and Construction Database:  
..... [www.nps.gov/dsc/dsgncnstr/susdb/](http://www.nps.gov/dsc/dsgncnstr/susdb/)
- ..... PRO-ACT Technical Inquiry 11007: VOC Levels from Carpets.
- ..... REDI-Guide of Building Materials: <http://oikos.com/redi/index.html>
- ..... Sustainable Building Technical Manual: Green Building Design, Construction and Operations, Public Technology, Inc., 1996.
- ..... USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.

ACTION ITEMS  
PRODUCT SELECTION

- ..... Select products that meet performance requirements and also limit environmental impact throughout their *life cycle*. Refer to Section C of Sustainable Building Technical Manual for a discussion of *life cycle* assessment techniques.
- ..... A. 1. — Evaluate traditional performance requirements, including
  - ..... Cost;
  - ..... Durability;

- ..... Fire rating, flame spread;
- ..... Acoustical performance; and
- ..... Energy performance.

A. 2. — Choose environmentally preferable product types where supporting information is available (for example, from AIA Resource Guide) based on the following criteria (see Building Materials Selection Tool for specific recommendations):

- ..... Raw materials that are non-toxic, salvaged, recycled or from a renewable source (woods from a certified sustainable source).
- ..... Production process that minimizes the use of energy, water and ozone depleting substances (ODSs) and limits toxic emissions and effluents.
- ..... Select products that meet performance requirements and also limit environmental impact throughout their *life cycle*.
- ..... Packaging and shipping that uses minimal, reusable or recycled packaging and that minimizes energy use for transport through efficient shipping and/or regional production.
- ..... Installation and use that enables safe installation and maintenance with minimal impact on Indoor Air Quality.
- ..... Resource Recovery that considers reuse and recycling of scrap material generated during installation as well as the material at the end of its useful life within the facility.
- ..... Compliant with EPA Guideline Requirements.

## choose products with compatible maintenance requirements

A. 3. — Choose products with compatible maintenance requirements to the greatest extent possible. Materials requiring dry maintenance should have adequate separation from materials requiring wet maintenance.

ACTION ITEMS  
INDOOR AIR QUALITY

..... Materials that are wet when applied release chemical contaminants into the facility as they cure. Materials with large amounts of exposed surface area, especially those that are “fleecy” in nature, can contribute significant emissions and also absorb other contaminants and re-emit them over time. Composite wood products generally contain formaldehyde that is emitted into the facility interior over time, and HVAC materials that are exposed to the airstream can release particulates, respirable fibers and Volatile Organic Compounds (VOCs) into the airstream.

B. 1. — Identify wet materials: includes paint, adhesives, sealants, caulks, wood preservatives and finishes, glazing compounds, floor leveling compounds.

B. 2. — Identify fleecy materials: includes insulations, carpet and padding and flexible fabrics which are exposed to the airstream or occupied space.

- B. 3. — Identify interior finish materials: includes gypsum board, ceiling tiles and panels, floor coverings, wall coverings, work surfaces, shelving.
- B. 4. — Identify composite wood products: Includes plywood, particle board, laminated wood beams, etc.
- B. 5. — Select carpets conforming to the VOC emission rate of 0.5 milligrams per square meter per hour (1.102 x 10<sup>-6</sup> lb. per 10.764 square feet per hour). This is a voluntary limit agreed to by the Carpet and Rug Institute and the EPA.
- B. 6. — Evaluate quantity and distribution of target materials within the facility. Materials used in large quantities should receive the greatest amount of review.
- B. 7. — Review manufacturer-supplied Material Safety Data Sheets (MSDS). Review MSDS to eliminate from consideration products with significant quantities of toxic, flammable, corrosive or carcinogenic material and potential for harmful chemical emissions.
- B. 8. — Consider results of emission tests of materials if documentation is provided by manufacturers (American Society of Testing Materials - ASTM D-5116).
- B. 9. — Eliminate internal duct lining. Use Mylar coated sound attenuators only where acoustical requirements cannot be met with unlined ductwork. Coordinate with architecture as cross section of unlined ductwork may be larger.
- B. 10. — Consider specification of anti-microbial treatments, for example, in carpet, textile or vinyl wall coverings, ceiling tiles or paints where microbial contamination is a particular concern. Anti-microbial agents in products must be EPA registered and have an EPA-accepted Technical Data Sheet for the specific application.
- B. 11. — Consider “breathable” wall finishes when circumstances allow (e.g., paint instead of vinyl wall covering) in hot and humid climates or micro-climates to reduce the possibility of moisture build-up. Do not use if they form a vapor barrier.
- B. 12. — Carpet fibers recycling programs are now offered by the major fiber companies, i.e., Dupont, BASF, etc.
- B. 13. — Require that all Hazardous Materials (HM) used in project get prior approval of the base Hazardous Materials Manager (HMM) function.

ACTION ITEMS  
LOCALLY  
MANUFACTURED  
MATERIALS

- Locally manufactured materials reduce shipping costs and energy use to transport products. Selection of materials that are locally recyclable will enhance construction waste recycling efforts.
- C. 1. — Select appropriate products and materials that are locally available.
- C. 2. — Identify local capabilities for recycling, especially for waste management purposes.

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ACTION ITEMS  
SPECIFICATIONS

Compare manufacturer-specific information to develop an environmental “performance specification.”

D. 1. — Identify distinguishing characteristics between products within a product type. Develop performance specification or choose competitive range of products that meet environmental criteria. (See Building Materials Selection Tool for specific recommendations.)

D. 2. — Highlight environmental considerations throughout the specification.

Require pre-construction conference.

Identify special environmental requirements in Division 1 section.

Require certification of environmental claims in submittal section.

Limit substitutions.

D. 3. — Identify secondary products (adhesives, finishes, sealants, etc.) within the specification.

ACTION ITEMS  
CONSIDER FUTURE USE

Thoughtful design can anticipate future reuse or recycling after the material or product’s useful life within the facility.

E. 1. — Design for disassembly, especially for facilities that anticipate a short service life. To facilitate disassembly and recycling consider snap release connectors, friction or other joints which do not require sealants.

E. 2. — Design for future recycling. Select materials that are recyclable and avoid composite materials, such as reinforced plastics and carpet fibers and backing, which are generally more difficult to recycle than homogenous materials, such as concrete. To facilitate recycling, consider labeling building materials with identification information.

INTRODUCTION

Reducing the amount of waste generated during construction and recycling the waste generated by users can lower a contractor's and a facility manager's landfill tipping fees, while at the same time conserving natural resources.

Plan for recycling during contract document development. Also, generate a hazardous materials management plan and minimize the use of ozone depleting materials.

Consider using the Defense Reutilization and Marketing Service

(DRMS), responsible for the disposal of excess personal property generated by the DOD. To carry out its mission, DRMS looks for ways to reuse or redistribute property within DOD, transfer to other federal agencies or donate goods to state and local governments and qualified nonprofit agencies.

DRMS

REFERENCE  
DOCUMENTS

- ..... American Forest and Paper Association (AFPA): National Wood Recycling Directory; [www.uga.edu/~soforext/wrdfinal.htm](http://www.uga.edu/~soforext/wrdfinal.htm)
- ..... Clean Washington Center: Recycling Plus Program Manual.
- ..... Defense Logistics Agency, DOD: Hazardous Materials Storage and Handling Handbook, Alexandria, VA, 1984.
- ..... Defense Reutilization and Marketing Service (DRMS); [www.drms.dla.mil/](http://www.drms.dla.mil/)
- ..... ETL 91-7: Chlorofluorocarbon (CFC) Limitation in Heating, Ventilating and Air Conditioning (HVAC) Systems, 21 Aug 91.
- ..... ETL 95-1: Halon 1301 Management Planning Guidance, 12 May 95.
- ..... Hazardous Material and Hazardous Waste, A Construction Reference Manual, R.S. Means Company, Inc.
- ..... Solid Waste Association of North America (SWANA): Construction Waste & Demolition Debris Recycling, A Primer, 1993; [www.swana.org/](http://www.swana.org/)
- ..... Triangle J Council of Governments: WasteSpec: Model Waste Specification for Construction Waste Reduction, Reuse, and Recycling.
- ..... USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.

ACTION ITEMS  
GENERAL  
CONSTRUCTION/WASTE  
DEMOLITION

- ..... By minimizing waste many efficiencies can be realized as what was previously waste becomes recognized as valuable material.
- ..... A. 1. — Reduce construction waste. Design with material modules in mind and carefully dimension drawings.
- ..... A. 2. — Participate in “take-back” programs to the maximum extent possible. Some manufacturers of building materials and products (e.g., many carpet manufacturers, some ceiling tile manufacturers) have initiated programs to take back scrap material after installation is complete, so that they can recycle the material.
- ..... A. 3. — State waste reduction goals clearly in the specification. Require orderly storage of materials and reuse of scrap materials for miscellaneous tasks (e.g., blocking, patching). Encourage suppliers to ship materials to the construction site using minimal, recyclable or reusable crates or packaging systems.



Markets currently exist for cost-effective recycling of many of the waste materials generated from construction and demolition, though there is regional variability in market value. By recycling, landfill tipping fees are avoided and valuable resources are conserved.

**B. 1.** — Require local contractor to recycle, instead of landfill, construction waste when cost effective. Typical recyclable construction materials are cardboard, metals, wood, land-clearing debris and concrete. Other common recyclables include asphalt, brick and gypsum. Landfill tipping fees vary nationwide, but when they are approximately \$50 per ton or more, it is usually cost-effective to recycle commingled waste rather than landfill it. Also, some materials such as cardboard and metals generate income.

**B. 2.** — Contact local waste disposal authority to identify local recycling markets for construction waste and list of local recyclers, haulers and building salvagers. Include sources in the specification.

### evaluate the feasibility of recycling additional materials

**B. 3.** — Develop final list of required construction materials for recycling (such as brick, concrete, metals, clean dimensional wood, land-clearing debris) based on evaluation of available recycling infrastructure in your area. Evaluate the feasibility of recycling additional materials such as engineered wood products, rigid foam insulation, glass, gypsum drywall, carpet and carpet padding, vinyl, etc.

**B. 4.** — Research recycling strategy based on local options; source separation on site, phase-based separation by hauler or commingled delivery to off-site materials recovery facility. Estimate the cost or savings to recycle using the Construction and Demolition (C & D) Economics Worksheet Tool to calculate and compare cost of landfill disposal with recycling.

**B. 5.** — Develop Construction and Demolition (C&D) Waste Recycling specification section. Require a C&D waste recycling management plan that identifies licensed haulers committed to participate in the project, fees, scheduled pick-ups and ultimate destination. Identify goals for quantity of materials to be recycled and a method for tracking quantity of materials actually recycled. (See WasteSpec for more guidance on recycling management plans).

**B. 6.** — Perform a site pre-assessment to identify materials feasible for salvage on demolition projects. If the pre-assessment findings are favorable, include a salvage plan in the specifications. Salvageable materials and equipment may include hardwood flooring, framing lumber, doors, windows, cabinets, hardware, plumbing fixtures, lighting fixtures, ductwork, wiring and piping. Determine requirements for site storage and transportation of materials to salvage company. Schedule adequate time for salvage work.



case study

During Phases One and Two of a project to replace over 2,000 housing units by 30th Civil Engineering Squadron/Facilities Design and Construction Flight (30 CES/CECE) at Vandenberg Air Force Base, environmentally responsible materials were specified and a wide variety of construction and demolition waste was recycled. Asphalt from roads from Phases One and Two was used to construct roads in laydown areas or as base material for new roads and walkways. Concrete from demolition of housing units (foundations of homes, curbs and driveways) from Phases Three and Four will be reused for newly aligned Utah Road.

In Phases One and Two the following recycled-content materials were used: playground equipment, carpet pad and particle board materials. This list is being expanded in subsequent project phases.

Low VOC paints, long-lasting concrete roof tiles and integrated color coat exterior plaster materials were specified as well as energy-efficient appliances.

Housing units slated for demolition have been used for training exercises by local and state firefighters. During new construction, wood and cardboard was recycled. Land-clearing debris, trees and shrubs, were chipped and recycled as on-site mulch and topsoil amendment. Landscape materials, appliances, electrical and plumbing fixtures, garage doors, sliding glass doors, doors, forced air units, cabinets and screens were reused on site, sold to salvage contractors, given to nonprofits or offered to a local federal prison for housing.

ACTION ITEMS  
FACILITY RECYCLING  
PROGRAM

Integration of recycling plans into the facility design can make collection of recyclables easy for facility occupants and maintenance personnel, thereby boosting success rates and revenues.

C. 1. — Design food service areas to allow for reusables (e.g., china, glassware and utensils) in place of disposables. Provide adequate space and facilities (e.g., dishwashing). Design galley areas to accommodate reusable mugs.

C. 2. — Integrate recycling containers into the design near the places where the waste will be generated (kitchens, galleys, copy rooms) and also near vertical circulation to aid collection.

C. 3. — Provide staging area for recyclables at loading dock.

C. 4. — Integrate the installation’s most current recycling efforts with each construction project. Plan for future expansion of recycling efforts as markets for recyclables expand.

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By substituting less hazardous materials whenever possible, environmental impacts are limited, reporting simplified and possible job site spills or injuries reduced. The OSHA Hazard Communication Standard applies to all employers, including those in the construction industry. “The Standard” is important for the well-being of workers, and to minimize spills or illegal dumping which can cause long-term environmental damage to sites.

D. 1. — Review materials for use in construction carefully to limit use of materials that will result in hazardous waste due to the hazardous nature of the material itself (e.g., solvent-based paints and adhesives, sealants, waterproofing, etc.), or the hazardous nature of materials used to clean up after use (e.g., solvent-based thinners, cleaners, paint removers, etc.). See Environmentally Preferable Building Materials Tool for detailed recommendations.

D. 2. — Require contractor to develop and maintain a hazardous materials inventory by work area and coordinate inventory with HM management function.

D. 3. — Identify safe holding area for hazardous materials and hazardous waste during construction. Separate by type and require appropriate Personal Protective Equipment (PPE) for workers handling the material.

D. 4. — Require contractor to develop a single Hazardous Materials Management Plan to address hazmat storage and hazardous waste management on the construction site. Level of detail in the plan must conform to base Environmental Flight requirements. Include as required submittal. Plan should describe expected types of hazardous waste; use of intermediate containers; movement procedures and designated storage areas; disposal; and spill prevention and response plan for on-site operations. (See “Hazardous Material and Hazardous Waste, A Construction Reference Manual” for details of hazardous waste management plan).

Because of the threat of global warming, chlorofluorocarbon (CFC) phase out is well underway in the United States. Hydrochlorofluorocarbons (HCFCs) are an imperfect substitute that still contribute to long-term damage; alternatives that do not deplete the ozone layer at all are preferred.

E. 1. — Use of CFC refrigerant is prohibited. If cooling system requires a refrigerant, use a hydrofluorocarbon (HFC) or HCFC refrigerant. See ETL 91-7.

E. 2. — Prohibit the use of halon for fire suppression systems. See ETL 95-1.

E. 3. — Institute a CFC and halon management plan in existing facilities. See ETL 95-1.

E. 4. — Select building materials that do not use CFC or HCFC blowing agents (such as those used in foams, adhesives and fabrics) where possible. (See Environmentally Preferable Building Materials Tool for detailed recommendations.)

## INTRODUCTION

During construction, waste reduction and indoor air quality are high priorities. The construction contractor should educate subcontractors about the three R's:

- ..... Reduce the amount of materials used;
- ..... Reuse materials on site; and
- ..... Recycle construction and demolition waste.

The construction contractor should also implement and enforce measures that ensure indoor air quality, such as installing wet materials first and providing proper ventilation during construction. The construction contractor should also educate members of the construction team about conserving water and protecting trees, topsoil, streams and other natural features during construction.

reduce reuse recycle



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REFERENCE  
DOCUMENTS

- ..... Solid Waste Association of North America (SWANA): Construction Waste & Demolition Debris Recycling, A Primer, 1993; [www.swana.org/](http://www.swana.org/)
- ..... Triangle J Council of Governments: WasteSpec: Model Waste Specification for Construction Waste Reduction, Reuse, and Recycling.
- ..... USAF Family Housing Guide for Planning, Programming, Design and Construction, Dec 95.

ACTION ITEMS  
GENERAL

- ..... Comply with Environmental Assessment/Environmental Impact Statement (EA/EIS) mitigations/specifications.
- ..... **A. 1.** — Highlight the importance of sustainable design provisions in the contract and at the pre-construction conference. Attention should be drawn to required plans such as site protection, erosion control, Hazardous Materials Management Plan, Integrated Pest Management Plan and waste minimization.
- ..... **A. 2.** — Educate all members of construction team about sustainable design and their role. During pre-construction and construction meetings, the construction contractor should educate all construction team members about waste reduction, site protection, water conservation and indoor air quality goals and specific practices they should implement to achieve these goals. In the pre-construction meeting to review goals, also include the following points:
  - Construction Waste Recycling:
    - ..... Requirements of construction waste recycling specification.
    - ..... Size and quantity of recycling container.
    - ..... Schedule for container pick-up.
  - Site Protection:
    - ..... Protection of trees and sensitive areas, such as creeks and wetlands.
    - ..... Location for staging areas, construction vehicles and travel routes.
  - Indoor Air Quality:
    - ..... IAQ specification sections, including installation practices.
- ..... **A. 3.** — Implement Quality Control Program to ensure compliance with specification that outlines environmentally sensitive practices and products.
- ..... **A. 4.** — Perform commissioning as required in the specifications. See Project Commissioning Tool for description of commissioning procedures during construction.

ACTION ITEMS  
SITE

- B. 1. — Avoid compaction of the soil. Establish staging areas and travel routes for construction vehicles and provide parking in specified areas for construction workers' personal vehicles. Implement specifications that protect areas adjacent to development from construction debris.
- B. 2. — Reuse on-site materials to the greatest extent possible. Stockpile existing topsoil for reuse. Consider shredding wood from land-clearing debris for use as mulch.
- B. 3. — Minimize vegetation disturbance and maximize its recovery by scheduling construction to take advantage of seasonal weather conditions to the maximum extent possible. Strip vegetation in early spring or late winter and revegetate in late spring or early winter as much as possible.
- B. 4. — Schedule the installation of permanent vegetation immediately upon completion of improvements such as streets, storm sewers or other features of the development if at all possible.
- B. 5. — Develop and implement approved storm water pollution prevention plans to control runoff during construction on larger construction sites. Develop and implement specifications requiring the use of debris, sediment or catch basins to remove heavy sediment loads from runoff water leaving the disturbed areas.

ACTION ITEMS  
WATER CONSERVATION  
AND QUALITY

- C. — Protect water sources from contamination during the construction process.

ACTION ITEMS  
INDOOR AIR QUALITY

- D. 1. — Require separate filtration media to be used during construction if permanent HVAC equipment is used for ventilation during construction. Contractor shall change all filter media in all HVAC units prior to occupancy, and before balancing commences and baseline IAQ testing is performed.
- D. 2. — Operate HVAC systems to flush the facility before occupancy. Ventilate with 100% outside air during installation of materials and finishes and during pre-occupancy.
- D. 3. — Carpet should be installed with good ventilation and continue to ventilate for 48 to 72 hours after installation, according to Carpet and Rug Institute and the Environmental Protection Agency (EPA).
- D. 4. — Sequence the installation of finish materials so that "wet" materials that will be high emitters of VOCs are installed before interior finish materials that can act as "sinks" - to the greatest extent possible. Require contractor to develop a sequence of finish installation schedule as a deliverable prior to construction.

ACTION ITEMS  
BUILDING MATERIALS

- D. 5. — Enforce installation of low-toxic materials. Verify that proposed material substitutions meet low-toxic requirements.
- D. 6. — Confirm that adequate access is provided for maintenance for all equipment.
- D. 7. — Protect the facility from contamination during construction. Cap duct ends to avoid contamination of interior duct surfaces or clean duct work prior to occupancy.

ACTION ITEMS  
WASTE MANAGEMENT

- E. 1. — Verify environmentally preferable building materials are provided as specified before subcontracts are finalized. Review proposed substitutions carefully to see that materials meet sustainability criteria as specified.
- E. 2. — Verify that vendors have used recycled-content, reusable or reduced packaging as much as feasible.
- E. 3. — Ensure contractor provides hazardous materials plan. Verify all hazardous materials (HM) to be used in project have prior approval from base Hazardous Materials Manager (HMM).
- F. 1. — Review details of the Construction and Demolition (C&D) Waste Recycling Management Plan. Schedule follow-up conferences to track progress. Designate one person with authority to communicate waste management program and all requirements to everyone on the job site.
- F. 2. — Coordinate construction waste recycling procedures with construction contractor, such as size of dumpsters, schedule for bin pick-up and available space at the job site for bins (especially for source separation which requires multiple bins). Identify staging area(s) for recyclables during construction.
- F. 3. — Quantify recycling efforts to determine whether recycling saved or cost money at the end of construction. Publicize successful construction waste recycling programs.

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## INTRODUCTION

Use technology such as energy management control system (EMCS), motion detectors for lighting control and energy-efficient office equipment to reduce energy consumption. User behavior is also a key factor in conserving energy and water and reducing operational waste throughout the facility's life. This includes shutting lights and equipment off when not in use and recycling paper, aluminum cans and other solid waste. Educational programs and signage, indoor air quality, energy and recycling managers may be necessary to raise awareness and change user behavior. Indoor air quality and preserving natural landscape are also important issues related to operating environmentally sensitive Air Force bases.

## Operations and Maintenance (O&M) is more than reducing

utility usage and the waste stream over the life of the facility. It is also minimizing other resources, such as labor, maintenance, equipment and materials.

Of course, regular maintenance, periodic inspections and facility assessments, which identify maintenance and repair problems early, will probably prolong useful life. One practical example: changing out light bulbs can maintain adequate lighting levels, eliminate expensive refixturing and improve overall efficiency.



REFERENCE  
DOCUMENTS

- AFCESA/ A-Gram, How to Select Energy-Efficient Electric Motors, Apr 96.
- AFEPPM 96-1: Air Force Energy Management Plan, 1 Jun 96.
- Commercial Cleaning Supplies, US General Services Administration (GSA), Federal Supply Service, Feb 96; [www.gsa.gov](http://www.gsa.gov)
- Construction Criteria Base (CCB), most current release, for energy and utility conservation guidance.
- Defense Reutilization and Marketing Service (DRMS); [www.drms.dla.mil/](http://www.drms.dla.mil/)
- EPA/NIOSH: 400/1 - 91/033: Building Air Quality: A Guide for Building Owners and Facility Managers, U.S. Government Printing Office, 12/91.
- EPA 832-R-94-009: Biosolids Recycling: Beneficial Technology for a Better Environment, U.S. Government Printing Office.
- ETL 88-4: Reliability and Maintainability (R&M) Design Checklist, 24 Jun 88.
- ETL 91-7: Chlorofluorocarbon (CFC) Limitation in Heating, Ventilating & Air Conditioning (HVAC) Systems, 21 Aug 91.
- GSA/EPA Green Clean program.
- MIL-HDBK 1165: Military Handbook Water Conservation (applies to retrofit projects).
- Model Pesticide Reduction Plan, Jun 97.
- USAF Guide to Buying Recycled, Jun 97.

ACTION ITEMS  
SITE

- A. 1. — Establish landscaping practices to protect wildlife habitats.
- A. 2. — Promote carpooling and other vehicle reduction efforts. For example, allocate parking spaces to give preference to high occupancy vehicles (HOV).
- A. 3. — Use organic fertilizers and natural techniques for insect control. Consider the use of commercial products containing biosolids and sludge from wastewater treatment plants as a soil amendment.
- A. 4. — Establish compost areas for appropriate food and yard waste. Utilize composted materials in planting beds.
- A. 5. — Mulch grass clippings and leaves.

ACTION ITEMS  
WATER CONSERVATION  
AND QUALITY

- B. 1. — Ensure proper operation of fixtures. Strive to exceed Energy Policy Act of 1992 (EPACT) requirements.
- B. 2. — Reduce the amount of water used for lawn and plant irrigation. For example, consider retrofit for drip irrigation. If irrigation is necessary, irrigate in the early morning or late afternoon to avoid loss of water from evaporation.
- B. 3. — Purchase front-loading washing machines and water-saving dishwashers.

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B. 4. — Educate building occupants and monitor water consumption.

Refer to MIL HDBK-1165.

case study

Since 1994, Luke Air Force Base, near Phoenix, Arizona, has been removing turf and replacing it with gravel and low water-consuming plant materials. In this effort, approximately 11,148 square meters (125,000 square feet) of land has been *Xeriscaped*.

ACTION ITEMS  
ENERGY

C. 1. — Review the comprehensive Operations and Maintenance Manual assembled by the contractor for the facility. Ensure the manual is transmitted to the facility manager.

C. 2. — Assure required personnel have been properly trained on equipment operation and maintenance on the specific equipment in the facility.

C. 3. — Periodically take the following actions:

Recalibrate lighting sensors, controllers and other devices;

Verify proper operation of air economizer dampers and automatic temperature control dampers

Perform recommended preventive maintenance on valves, actuators and other control devices.

Verify status of control setpoints and confirm they are reasonable;

Review automatic start/stop and reset schedules for equipment to confirm they coincide with current building operation and occupancy patterns;

Revise controls setpoints and verify correct automatic responses by system components.

C. 4. — Optimize the use of daylight. Install energy-efficient lights, motion detectors, daylight sensors and timers and clean equipment regularly. Establish educational and promotional programs that encourage staff to turn off lights whenever practical.

C. 5. — Purchase equipment with the EPA's Energy Star label. Establish educational and promotional programs that encourage staff to turn off office equipment whenever practical.

C. 6. — Heating and cooling should be regulated to coincide with the occupancy schedule. Schedule overrides should be limited to night setback temperatures, and based on a time duration of one hour.

C. 7. — Turn off all equipment when not in use and keep refrigerator doors closed. Brush or vacuum refrigerator coils, replace loose-fitting seals on all refrigerators, properly dispose of unused refrigerators. Purchase energy-efficient kitchen equipment.

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ACTION ITEMS  
INDOOR AIR QUALITY

- C. 8. — Purchase instantaneous water heaters for local use wherever practical. Operate large recirculating systems only on a time-of-day schedule which coincides with the occupancy schedule.
- C. 9. — Set domestic hot water temperatures as low as possible, i.e., 43.33 degrees Celsius (110 degrees Fahrenheit) maximum except for food service areas where a local booster heater shall be used.
- C. 10. — Select energy-efficient replacements for electric motors.
- C. 11. — Check power factor to verify that current and voltage are at .9 or greater.
- D. 1. — Procure low-toxic cleaning products and office supplies. Use cleaning products that are low in VOCs and contain moderate levels of pH, about 7. Use citric-based biodegradable degreasers and cleaners. Avoid disinfectants containing trichlorophenol, cresol, benzalkonium chloride and formaldehyde, and detergents containing phosphates. Refer to pages 3-15, “Biodegradable Cleaners and Degreasers,” from Commercial Cleaning Supplies, US General Services Administration (GSA) Federal Supply Service, Feb 96.
- D. 2. — Purchase adhesives, sealants, correction fluids and paint with the least amount of VOCs.
- D. 3. — Inspect mechanical ventilation or air conditioning ductwork where fitted and ensure that there is no visible freestanding water.
- D. 4. — Maintain HVAC system for proper ventilation. Inspect the filter fitted to the air conditioning system. Where possible introduce a filter system which is capable of removing particles as small as pollen.
- D. 5. — Follow ETL 91-7 for containing, converting or replacing HVAC equipment using CFCs.
- D. 6. — Clean or replace filters routinely in HVAC equipment.

case study

In response to building occupant complaints and out of a desire to provide a safe, productive and benign indoor environment, GSA and EPA cooperated in designing a pilot “green” housekeeping program to minimize the impact of cleaning agents on indoor air quality. EPA Region 2 is the tenant in the GSA-owned federal office tower which served as the pilot site. EPA and GSA entered an informal partnership with the custodial contractor and a supplier of cleaning products. All cleaning products and procedures were evaluated. Cleaning procedures were changed, new water-based products were formulated to meet tight safety criteria, and a “chemizer” was employed to mix cleaning agents from concentrate on demand. Benefits from the new approach included reduced complaints from cleaning staff and building occupants; projected 50% reduction in the amount of chemical cleaning products used; reduction in disposal of waste cleaning agents whose shelf life has expired; significant reductions in the amount of packaging waste requiring disposal; and reduced VOC emissions. GSA is now working to expand this successful pilot project into other facilities.

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- E. 1. — Contact the Defense Reutilization and Marketing Service (DRMS) to reutilize, transfer or donate virtually anything in the Department of Defense (DOD) system from televisions to textiles to typewriters to recovered refrigerants. These items are available to DOD agencies, other government agencies, educational institutions and nonprofits.
- E. 2. — If it meets the mission of the user, carefully consider refurbishing existing furniture systems instead of buying new. Also consider procuring refurbished furniture instead of new; however, some refurbished furniture (reupholstery) is often the same cost or more costly than buying new, and refinishing of wood items is not responsible if work can't be done in contained area or items taken to a refinishing shop. Some recycled products do not meet commercial use quality/safety standards, and some existing furniture may not be able to be refinished to meet current codes.
- E. 3. — Recycle cardboard, newspaper, aluminum cans, glass, plastic and oil at a minimum.
- E. 4. — Purchase recycled-content, non-toxic supplies.
- E. 5. — Purchase supplies in bulk containers to lessen packaging waste.
- E. 6. — Ask vendors to take back shipping containers and pallets.
- E. 7. — Use recycled printer and photocopier cartridges.
- E. 8. — Dispose of ballasts containing polychlorinated biphenyls (PCBs) according to the Toxic Substance Control Act (TSCA), which states that it is permissible to dispose of nonleaking PCB ballasts in a sanitary landfill. The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requires facility owners and waste generators to notify the National Response Center (NRC) (1-800-424-8802) when disposing of half a kilogram (a pound) or more of PCBs (12 to 16 ballasts) in a 24-hour period.

INTRODUCTION

Post-Occupancy Evaluations (POE) (performed through the Facility Manager in coordination with the Engineering Flight) measure a facility’s water and energy consumption, indoor air quality, the amount of waste generated and other issues associated with operating environmentally responsible facilities. (See Appendix F.)

In addition to facility performance, a POE also examines whether an environmentally sensitive project was more expensive and time-consuming. Facility performance data establishes a benchmark for future reference. Both performance and cost information educate the team for future projects.

Use data from utility meters for water, electricity and natural gas.

POE also evaluates Operations and Maintenance practices.

[POE]

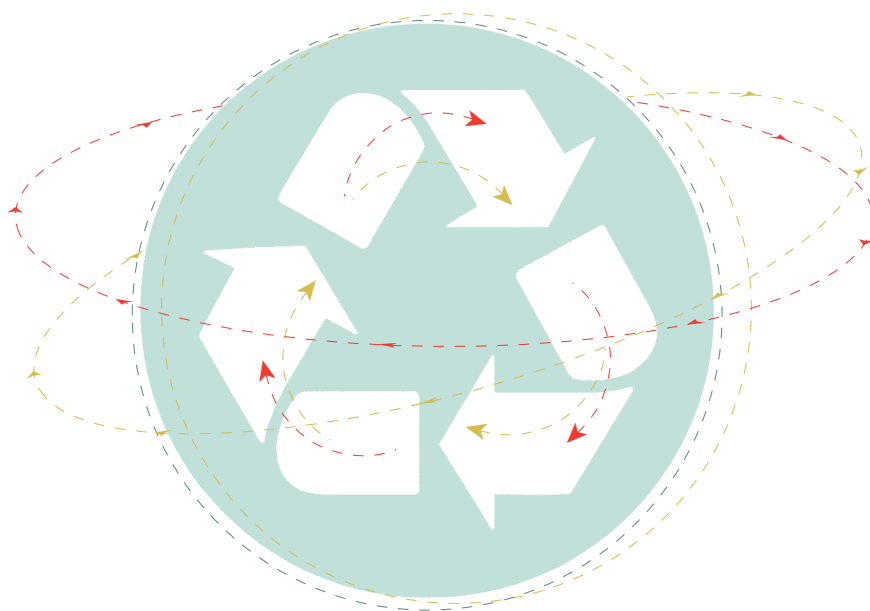
REFERENCE DOCUMENTS	<p>Commercial Buildings Energy Consumption and Expenditures 1992, Department of Energy, NTIS Order # DE95009672.</p> <p>EPA/400/1-91/033: Building Air Quality: A Guide for Building Owners and Facility Managers, U.S. Government Printing Office, Dec 91.</p> <p>ETL 94-4: Energy Usage Criteria for Facilities in the Military Construction Program (MCP), 19 Aug 94.</p>
ACTION ITEMS GENERAL	<p>A. — Track cost of environmental and energy-efficient measures compared to traditional measures.</p>
ACTION ITEMS WATER CONSERVATION AND QUALITY	<p>B. 1. — Quantify water consumed for irrigation.</p> <p>B. 2. — Quantify water consumption in facilities.</p> <p>B. 3. — Measure water quality.</p>
ACTION ITEMS ENERGY MONITORING	<p>C. — If appropriate monitoring equipment has been incorporated into a renovated facility, then compare your energy usage with your energy budget. The monitoring of energy usage in a new facility is mandatory and must be compared to the Energy Usage Budget (EUB).</p> <p>D. 1. — Quantify connected interior lighting load in watts per square meter (W/SM) (watts per square foot (W/SF)).</p> <p>D. 2. — Quantify energy consumed in connected plug load in W/SM (W/SF).</p> <p>D. 3. — Quantify the efficiency of the mechanical cooling system in W/SM (W/SF).</p> <p>D. 4. — Measure cooling load and, if possible, measure air handling equipment loads in kilowatts per metric ton (K/MT) (1 short ton = .9072 metric tons).</p>
ACTION ITEMS INDOOR AIR QUALITY	<p>E. 1. — Measure indoor air quality. Refer to EPA/400/1-91/033: Building Air Quality: A Guide for Building Owners and Facility Managers for list of air contaminants to test for (volatile organic compounds, biological contaminants, airborne dust, combustion production, etc.) and equipment with which to identify and measure levels.</p>
ACTION ITEMS WASTE MANAGEMENT	<p>Quantify waste recycled and landfilled.</p>

**INTRODUCTION**..... Excess facilities should be evaluated for reuse instead of demolishing and land-filling them. Explore reusing them “as is” by another Air Force or other federal government tenant or renovating all or part of the facility.

In addition, facilities that no longer meet the users’ needs should be evaluated for additions and/or alterations versus building new. The Base Facility Utilization Board may be useful as a clearinghouse for this process.

If the facility is in poor condition or no adaptive reuse can be found, recycle and salvage component parts to the greatest extent possible.

Historic preservation or adaptive use represents the ultimate in recycling.



AFI 32-7065: Cultural Resources Management

Defense Reutilization and Marketing Service (DRMS): [www.drms.dla.mil/](http://www.drms.dla.mil/)

A. 1. — Critically evaluate structural integrity, facility skin, HVAC system, functional suitability, compliance with current codes, historical significance and other aspects to determine whether existing facility can be reused.

A. 2. — Prepare a salvage plan for materials and equipment that will not be reused in the renovation, such as framing lumber, hardwood flooring, carpet, doors, windows, cabinets, hardware, plumbing fixtures, lighting fixtures, ductwork, wiring and piping. Schedule a walk through with local facility salvager(s) to determine what items have value for resale or reuse. Contact Defense Reutilization and Marketing Service. DRMS reuses or redistributes Department of Defense (DOD) property within DOD, transfers to other federal agencies, or donates goods to state and local governments and qualified nonprofit agencies. To donate materials, contact local nonprofit organization, such as Habitat for Humanity.

A. 3. — Include salvage plan in specifications. Determine requirements for site storage and transportation to salvage company. Remove salvageable items as early in the project as possible.

A. 4. — Although more time consuming, remove salvageable items by disassembly. Schedule adequate time.

A. 5. — During renovation, other materials should also be recycled, such as concrete, brick, metal, wood and gypsum.

## case study

During Phase One and Two of a 294-unit housing replacement project at Vandenberg Air Force Base, a wide variety of construction and demolition waste was recycled. Asphalt from roads from Phases One and Two was used to construct roads in laydown areas or as base material for new roads and walkways.

Housing units slated for demolition have been used for training exercises by local and state firefighters. Land-clearing debris, trees and shrubs, were chipped and recycled as on-site mulch and topsoil amendment. Landscape materials, appliances, electrical and plumbing fixtures, garage doors, sliding glass doors, doors, forced air units, cabinets and screens were reused on site, sold to salvage contractors, given to nonprofits or offered to a local federal prison for housing.

Concrete from demolition of housing units (foundations of homes, curbs and driveways) from Phases Three and Four will be reused for newly aligned Utah Road.

A. 6. — If adaptive use of the facility is not possible, or the facility is in very poor condition, follow the salvage and recycling procedures outlined above prior to demolition. Demolition by grinding up the majority of the structure has advantages in terms of the economics of lead paint disposal, but precludes salvage of most construction materials.

RESOURCE LIST

RESOURCE  
LIST  
GOVERNMENT SOURCES

NOTE: All ETLs available on the Construction Criteria Base (CCB)  
CDs or web site; [www.nibs.org/ccb/ccb1.htm](http://www.nibs.org/ccb/ccb1.htm)

Available on each base:

- Base Architectural Compatibility Guidelines.
  - Base Landscape Plan.
  - Base Pollution Prevention Management Action Plan (P2MAP).
  - Base Storm Water (P2) Management Plan.
  - FARS, AFFARS at Base Contracting Office:
  - FAR Revision 5/31/95, 60 FR 28494 (FAR 36.602-1).
  - FAR 52.223-4, Recovered Material Certification.
  - FAR 52.223-8, Estimate of Percentage of Recovered Material for EPA Designated Items to be Used in the Performance of the Contract.
  - FAR 52.223-9, Certification and Estimate of Percentage of Recovered Material Content for EPA Designated Items.
  - The Secretary of Interior’s Standards for Rehabilitation. (Available from Base Cultural Resource Manager).
  - National Environmental Policy Act (NEPA) document developed in Planning Phase.
  - Sustainability Goals document developed in Planning Phase.
- (See example on AFCEE website).

Available from other Government Sources:

- 10 Code of Federal Regulations (CFR) 435: Performance Standards for New Commercial & Multifamily High Rise Residential Buildings (compliance required by 1992 Energy Policy Act - Public Law 108-482).
- 10 Code of Federal Regulations (CFR) 436, Part A, Methods and Procedures for Life Cycle Analysis and the Tri-Service Memorandum of Understanding (MOA).
- AFCEA A-Gram: How To Select Energy Efficient Electric Motors, Apr 96.
- Air Force Energy Program Procedural Memorandum (AFEPPM) 96-1: Air Force Energy Management Plan, 1 Jun 96.
- AFEPPM 96-2: Air Force Water Management Plan, 1 June 96.
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ACRONYMS

ACRONYMS

ACC	Air Combat Command
A/E	Architect/Engineer
AFCEE	Air Force Center for Environmental Excellence
AFCESA	Air Force Civil Engineering Support Agency
AFEPPM	Air Force Energy Program Procedural Memorandum
AFFARS	Air Force Federal Acquisition Regulations
AFI	Air Force Instruction
AFPA	American Forest and Paper Association
AFR	Air Force Regulation
AIA	American Institute of Architects
AMC	Air Mobility Command
ANSI	American National Standards Institute
APP	Atactic Polypropylene
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASTM	American Society of Testing Materials
BASH	Bird Air Strike Hazard
BEPAC	Building Environmental Performance Criteria
BLAST	Building Loads Analysis and Systems Thermodynamics
BREEAM	Building Research Establishment Environmental Assessment Method
BTU	British Thermal Unit
C	Centigrade
C&D	Construction and Demolition
CBD	Commerce Business Daily
CCB	Construction Criteria Base
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CFC	Chlorofluorocarbons
CFM	Cubic Feet per Minute
CFR	Code of Federal Regulations
CI	Coolness Index
CID	Comprehensive Interior Design
CITES	Convention on International Trade and Endangered Species
CMU	Concrete Masonry Unit
CO <sub>2</sub>	Carbon Dioxide

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## ACRONYMS

CONUS	Continental United States
CPG	Comprehensive Procurement Guidelines
CSI	Construction Specifications Institute
DA	Design Agent
DBH	Diameter Breast Height
DI	Design Instruction
DNL	Day/Night Average Level (in decibels)
DOD	Department of Defense
DOE	Department of Energy
DRMS	Defense Reutilization and Marketing Service
EA	Environmental Assessment
ECD	Estimated Completion Date
ECIP	Energy Conservation Investment Program
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
EMCS	Energy Management and Control System
EO	Executive Order
EPA	Environmental Protection Agency
EPACT	Energy Policy Act
ESPC	Energy Savings Performance Contract
ETL	Engineering Technical Letter
EUB	Energy Use Budget
FAR	Federal Acquisition Regulation
FLEX	Federal Lighting Energy Expert
FPS	Feet per Second
FRP	Fiberglass Reinforced Plastic
GGBF	Ground Granulated Blast Furnace
GPF	Gallons per Flush
GPL	Grams per Liter
GPM	Gallons per Minute
GSA	General Services Administration
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
HHW	Household Hazardous Waste
HID	High Intensity Discharge

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## ACRONYMS

HK-BEAM	Hong Kong Building Environmental Assessment Method
HM	Hazardous Materials
HMM	Hazardous Materials Manager/Management
HOV	High Occupancy Vehicle
HQ	Headquarters
HVAC	Heating, Ventilating and Air Conditioning
IAQ	Indoor Air Quality
IAW	In Accordance With
IES	Illumination Engineering Society
ILE	Installation and Logistics Engineering
ILEV	Installation and Logistics Environmental Engineering
IP3	Installation Pollution Prevention Program
IRP	Installation Restoration Program
K/MT	Kilowatts per Metric Ton
K/T	Kilowatts per Ton
KW	Kilowatts
LCCA	Life Cycle Cost Analysis
LCCID	Life Cycle Cost in Design
LED	Light Emitting Diodes
LEED	Leadership in Energy and Environmental Design
LPF	Liters per Flush
LPM	Liters per Minute
MAJCOM	Major Command
MAP	Management Action Plan
MCP	Military Construction Program
MDF	Medium Density Fiberboard
MILCON	Military Construction
MIL-HDBK	Military Handbook
MOA	Memorandum of Agreement
MSDS	Material Safety Data Sheet
NAF	Non-Appropriated Funding
NAVFAC	Naval Facilities Engineering Command
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health

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## ACRONYMS

NPDES	National Pollution Discharge Elimination System
NRC	National Response Center
NSF	National Science Foundation
OCONUS	Outside Continental United States
O&M	Operations and Maintenance
ODP	Ozone Depleting Product
ODS	Ozone Depleting Substance
OSB	Oriented Strand Board
P2	Pollution Prevention
P2MAP	Pollution Prevention Management Action Plan
PA	Programmed Amount
PACES	Parametric Cost Engineering System
PAO	Polyalphaolefin
PCB	Polychlorinated Biphenyl
PCCIE	Power Conditioning and Continuation Interfacing Equipment
PET	Polyethylene Terephthalate
PM	Project Manager
PMP	Project Management Plan
POC	Point of Contact
POE	Post-Occupancy Evaluation
PPE	Personal Protective Equipment
PPM	Parts per Million
PVA	Polyvinyl Acetates
PVC	Polyvinyl Chloride
R	Resistance (measure of insulation value)
R&M	Reliability and Maintainability
RAMP	Requirements and Management Plan
RAP	Recycled Asphalt Paving
RD	Requirements Document (part of RAMP)
RMAN	Recovered Material Advisory Notice (EPA)
SA	Solar Amount
SB	Styrene Butadiene
SBR	Styrene Butadiene Rubber
SCS	Scientific Certification Systems
SF	Square Foot

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CHAPTERS

ACRONYMS

SM	.....	Square Meter
SMACNA	.....	Sheet Metal and Air Conditioning Contractors National Association
SOW	.....	Statement of Work
SWANA	.....	Solid Waste Association of North America
THD	.....	Total Harmonic Distortion
TRI	.....	Toxic Release Inventory
TSCA	.....	Toxic Substance Control Act
TVOC	.....	Total Volatile Organic Compounds
USC	.....	United States Congress
USDA	.....	United States Department of Agriculture
UST	.....	Underground Storage Tank
VAV	.....	Variable Air Volume
VCT	.....	Vinyl Composition Tile
VOC	.....	Volatile Organic Compound
WARP	.....	Woodworkers Alliance for Rainforest Protection
WQ	.....	Water Quality
W/SF	.....	Watts per Square Foot
W/SM	.....	Watts per Square Meter
YR	.....	Year

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DEFINITIONS

DEFINITIONS

*base case building:* Similar building type in similar climate, used for comparison purposes.

*environmentally preferable:* Products or services that have a lesser or reduced effect on human health and the environment when compared with other products and services that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance or disposal of the product or service. For nearly every building product and system there are alternatives. These alternates have differing environmental impacts. In most cases, there are practical and affordable solutions that are significantly better in meeting environmental needs.

*heating pick-up load factor:* The additional capacity of HVAC equipment to warm a building quickly.

*household hazardous waste:* Products used in the home, such as cleaners, oils and pesticides, containing hazardous and toxic chemicals, which, when discarded, become *household hazardous waste* (HHW). HHWs are further defined as discarded materials and products that are ignitable, corrosive, reactive, toxic or otherwise listed as hazardous by the United States Environmental Protection Agency (EPA). Products used and disposed of from a typical military residence that may contain hazardous ingredients include insecticides and pesticides, motor oil and automotive supplies, paints and thinners, stains, varnishes, glues, heating oil, medicines, cosmetics, batteries, cleaners, polishes, fluorescent light bulbs, thermometers, ink, swimming pool chemicals, smoke detectors and many other common household items. The typical American household contains products with more than 100 substances listed as hazardous by the U.S. Environmental Protection Agency.

*insolation:* A measure of the amount of solar radiation striking a surface. Maximum insolation of the earth's surface occurs when the sun is directly overhead and is about 1,000 watts per square meter.

*life cycle:* The *life cycle* of a product extends from the original procurement of raw materials, through its refinements, its manufacturing, shipping and installation, its use and, finally, its disposal. Each step has an environmental impact. Similar products can have widely different up- and downstream impacts on the environment. Understanding these differences enables the user to make responsible decisions.

*neglected site:* One that has been underutilized and/or abandoned.

*R-value:* Resistance, the measure of a material's resistance to conducting heat. The higher the number, the greater the resistance or insulation.

*sick building syndrome:* A pattern of health complaints related to poor indoor air quality. Symptoms include eye, nose and throat irritation, nausea, fatigue, depression, headaches and skin irritations. The symptoms disappear when one is away from the affected building for a period of time (hours or days).

*thermal bridging:* Materials in contact which allow the transfer of energy (conducting heat or cold) from outside to inside and/or vice versa.

*U-value:* Measure of thermal transmission.

*Xeriscape:* Landscape planting concept utilizing native or adapted plant materials together with improved methods of soil preparation, irrigation and materials for retaining soil moisture.

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## APPENDIX A

### A-E SELECTION AND STATEMENT OF WORK TOOL

#### Overview

The USAF has implemented a variety of energy saving and pollution prevention strategies in the planning, design and construction of many facilities. By addressing these issues simultaneously the USAF will gain the synergy of realizing each of these goals contributing to the whole.

Sustainable design is an integrated systems approach to creating the built environment. In order to realize sustainability goals, the A-E must coordinate the design of the following in an iterative manner to create a cost effective, durable, and energy efficient facility:

- Mechanical
- Electrical
- Structural
- Thermal Envelope
- Daylighting / Fenestration
- Materials Selection
- Indoor Air Quality
- Life Cycle Cost

#### Reference Documents

EO 12873: Federal Acquisition, Recycling and Waste Prevention, address:  
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EPA Energy Star Program Equipment and Buildings, address:  
<http://es.inel.gov/partners/estar/estar.html>

FARS and AFFARS, Base Contracting Office

## **SELECTING THE A-E FIRM**

The process begins when the AF publishes its notice of intent to contract with an A-E firm in the Commerce Business Daily (CBD). Firms wishing to compete for the design will submit packages to the Contracting Officer for evaluation. Selection boards consisting of experienced engineers and architects evaluate these proposals using the criteria in the CBD, and rank the A-E firms in order of preference. Three actions are required to ensure the selection of an A-E with sustainable design experience:

- Include sustainable design experience in the selection criteria published in the CBD announcement;
- Make sustainable design experience a deciding factor in the selection by “weighting” it appropriately (when compared to the other selection criteria used in the process);
- Assist personnel on the selection board to understand the basics of sustainable design, so they can interpret and evaluate the proposals effectively.

### **Selection Criteria in the CBD Announcement**

The CBD announcement provides a synopsis of the project, expertise and special requirements for the designer, selection criteria, and specific submittal requirements including Standard Forms (SF) 254 and 255 to establish the A-E’s qualifications.

All criteria to be used by the selection board in evaluating the A-E firms must be stated in the CBD announcement. The criteria vary according to specific needs, but generally include the items listed below. This covers mandatory provisions now in FARS and AFFARS on A/E selection criteria related to experience in design using recyclable materials.

- (1) “Professional qualifications necessary for satisfactory performance of required services;

- (2) Specialized experience and technical competence in the type of work required;
- (3) Capacity to accomplish the work in the required time;
- (4) Past performance on contracts with Government agencies and private industry in terms of cost control, quality of work, and compliance with performance schedules;
- (5) Location in the general geographical area of the project and knowledge of the locality of the project; *provided*, that application of this criterion leaves an appropriate number of qualified firms, given the nature and size of the project; and
- (6) *Demonstrated success in prescribing the use of recovered materials and achieving waste reduction and energy efficiency in facility design."*

Source: FAR 36.602, ©1995, Commerce Clearing House, Inc.

### **Items to Consider when Evaluating A-E Experience**

The A-E firm will submit its proposal in response to the CBD announcement. The selection board may be given written guidance to help them prepare their evaluations of the proposals. Providing the selection board with guidance to help them evaluate sustainability experience will help them carry out their duties. This guidance can vary from project to project, depending on the specific sustainability goals which have been established by the project team.

You may want to consider some or all of the following when evaluating A-E firms' experience in sustainable design:

- The firm's expertise with environmentally responsible/ sustainable facility design should be explained.

*Note: In reviewing the narratives, look for comparisons to industry standards and broad experience integrating several disciplines. For example, firms who specify daylighting or energy efficient lighting but don't incorporate energy efficient building "skins" or mechanical systems have not grasped the total concept.*

- A-E may demonstrate experience with projects that use less heating and cooling energy than industry standards. Firms may be requested to list the number of projects, and on two describe briefly the strategy used to reduce the HVAC energy. A-E firms should use simple language such as "R=40 roof + R=30 walls" or "Gas filled low-E windows," and identify industry standards.
- A-E may demonstrate experience with projects that use less electrical energy (per square foot and/or per square meter) and less energy for lighting than industry standards. A-E should indicate any projects that are EPA Energy Star compliant. A-E firms should use simple language and identify industry standards.
- A-E may demonstrate experience with projects that have specifically addressed ensuring good indoor air quality, including such measures as specifying low VOC adhesives, low VOC paints, low-toxic building materials, or above-code required air exchanges. Projects which are designed with Integrated Pest Management techniques in mind reduce the use of toxic pesticides, and also contribute to indoor air quality.
- A-E may describe past projects demonstrating site planning that works with the natural environment, maximizes solar energy potential and use of natural light and ventilation, and minimizes offsite storm water runoff.

- A-E may demonstrate experience in writing specifications requiring waste management and recycling plans for project construction and demolition (C&D). If the A-E demonstrates access to local market data for C&D material reuse and knows what materials will sell and who to sell it to, they should be given extra credit. A successful past project would demonstrate a cost effective C&D management effort that reused materials on site and recycled as much as possible of what they could not reuse. 40% C&D material diversion from the landfill (by weight) would be acceptable; 75 to 80% diversion would be outstanding.
- A-E may demonstrate knowledge of the EPA Comprehensive Procurement Guidelines for recycled-content building materials and have written specifications requiring the use of recycled-content materials. If the A-E has developed a database of suppliers, they should be given extra credit – it takes a lot of time to research the possible materials, determine their technical feasibility, and compare their costs with virgin-material products.
- A-E may demonstrate experience using life cycle analysis techniques to select building materials which minimize environmental impacts throughout their life cycle (especially maintenance and ultimate disposal).
- A-E may demonstrate experience with life cycle cost analysis. This technique is the key to justifying the use of materials and systems that have a higher first cost, but pay for themselves quickly due to decreased utility costs or maintenance requirements.
- The submittal should provide a list of client references for sustainable design.

*Note: Call them.*



- The submittal should include a resume of the Architect/Engineer who will be in charge of this project. Include this person's experience with sustainable design projects.
- Submittal should detail a sample sustainable project previously designed by the A-E. This information may include:
  - Size of project (preferably above 15,000 square feet)
  - Measures taken for:
    - Site work (Chapter 6 of the Guide)
    - Water quality and conservation (Chapter 7)
    - Energy conservation (Chapter 8)
    - Materials selection (Chapter 9)
    - Resource efficiency and waste management (Chapter 10)
    - Enhanced indoor air quality
    - Durability and maintainability
  - Description of Client Satisfaction

## **STATEMENT OF WORK**

The Statement of Work defines the task to be performed by the chosen A-E firm. Language such as the following may be included in the Statement of Work for design of projects incorporating sustainability goals.

### **General Scope of Services section**

Environmentally-responsible design is a (*facility identification*) priority, partly due to Executive Orders such as EO 12902, which require federal agencies to conserve natural resources such as energy and water. Through these orders and others we intend to reduce the environmental impact of building design, construction and operation, and share our experiences with other Air Force and DoD organizations.

**OR:**

Special emphasis is being placed on environmentally sensitive materials, recycling, and “green” design and construction principles in this project. This emphasis is added to comply with various executive directives meant to help alleviate the drain of natural resources and reduce the negative aspect to the environment some aspects of the construction industry have caused. This emphasis will also provide valuable experience with environmentally responsible design and construction which will be shared with other Air Force and Department of Defense organizations.

### **Design Charette**

The A-E shall conduct a design charrette at (*facility identification*) with the purpose of developing floor plans, elevations, preliminary site and utility layout, and cost estimates for approval by Government user groups. Representatives of the various disciplines represented in the A-E team should attend the charrette in order to address all areas involved in the project, especially sustainable design. Include an environmental awareness session with all key team members at the charrette kick-off. The A-E must provide a clear status of impacts of design decisions on project cost throughout the charrette. The charrette is anticipated to last no more than one week and will require daily presentations to the Base leadership as well as a final presentation.

### **Energy and Environmentally-Conscious Design**

Environmentally responsible design considerations are discussed in the Air Force Environmentally Responsible Facilities Guide. To the maximum extent possible and practicable, the design shall incorporate recycled content materials as mandated by EPA’s Comprehensive Procurement Guidelines (CPG) and ETL 94-7. Non-availability of materials or technologies, lack of competition, failure to meet performance standards, and unreasonable price are all valid reasons for exclusion of CPG items. Note that in addition to fulfilling the CPG requirements, designers should explore other construction alternatives in the Environmentally Responsible Facilities Guide, as well as other aspects of “green” design and construction currently practiced in industry yet not mandated by EPA or the Air Force. The ultimate goal is to increase sustainability in

construction, yet common sense must be applied to decisions made in this area.

### **Design Submittals and Reviews**

The A-E shall review the concept design developed at the Charette in accordance with the emphasis on environmentally sensitive materials, recycling, and sustainable design and construction principles cited in paragraph XXX (*from the General Scope of Services section of the SOW*). The A-E shall incorporate sustainable design recommendations into the specifications at the \_\_% design submittal and clearly indicate these recommendations using bold-italicized lettering. A narrative shall also be provided in the Design Analysis submittal which clearly indicates the sections of the specification supporting sustainability goals. This narrative shall be supported with manufacturer's catalogue sheets and information describing recycled material content or other environmental attributes for the materials selected. These catalogue sheets, together with cost information, will be used to document compliance with the project's environmentally responsible design goals.

If unusual design features or conditions are included in the project which materially affect the cost, attach backup information to the construction cost estimate, with sufficient explanation and cost information to support them. This is a very important part of the analysis for including recycled content items from the EPA Comprehensive Procurement Guidelines (CPG) into the project design and specifications.

### **Construction Cost Control**

When preparing cost estimates, the A-E should identify environmentally responsible design solutions that have significantly increased the initial project cost. Back-up sheets, with cost data and text providing justification for the solution, should be attached to the estimate. This information is necessary to determine whether such design solutions should be included in the project. The A-E will consider all design options and criteria reductions that may be necessary in those instances where possible cost overruns may be experienced. This information will also be included in the Design Analysis.

**OR**

If a design solution results in increased first costs, but is expected to result in long-term savings to the Government, the A-E shall perform life cycle cost analysis to quantify the savings. The results shall be included in the Design Analysis.

### **Additional Meetings and Studies**

The A-E shall be required to attend one design process analysis meeting. The purpose of this meeting is to assess the Government's efforts to implement sustainable design and construction requirements into the project and review any lessons learned from the overall effort. The meeting will be conducted as a round table discussion session. The A-E will provide a written analysis of the environmental goals of this project and the design's success in meeting these goals. The A-E shall also provide a summary of tools examined and processes used to research and implement these goals and their results. Cost comparisons and estimates of solid waste diverted from landfill shall be provided as back-up information. Additionally the A-E shall provide a summary of the actual man-hours expended by the A-E Design Team to implement these requirements.

## APPENDIX B

### DESIGN SOLUTION DOCUMENTATION TOOL

The purpose of this tool is to document technologies, products and practices used in the final construction and tie them back to the original design goals established at the beginning of the project. By recording these decisions as they are made during design and construction, other teams can learn and apply information to future projects. The AF Project Manager or his/her designee is responsible for the completion of this information and sharing it with other installation and MAJCOM project managers.

<b>Sustainable Design Decision</b>	<b>Options</b>	<b>Considerations</b>	<b>Expert Decision Maker</b>	<b>Project Goal or Air Force Policy</b>

See Example on following page.

### **Design Solution Documentation Example**

<b>Sustainable Design Decision</b>	<b>Options</b>	<b>Considerations</b>	<b>Expert Decision Maker</b>	<b>Project Goal or Air Force Policy</b>
Management of Concrete from Demolition	1) Landfill 2) Crush and reuse onsite as fill or aggregate 3) Crush and use in future project	Costs: rent, lease, purchase crushing equipment; or contract for crushing services  Possible environmental permitting requirements	Joint decision – CEC (for technical feasibility) and CEV (for environmental feasibility)	Solid waste diversion from landfill
Material Selection for Privacy Fences	1) Cedar fence boards 2) Plastic lumber fencing 3) Cedar boards with plastic fence posts	Aesthetics  Durability  Maintenance (plastic never needs staining or painting)	CEC design manager	Use of environmentally preferable materials in accordance with EO 12873

## **APPENDIX C**

### **ENVIRONMENTALLY PREFERABLE BUILDING MATERIALS TOOL**

#### **Introduction**

The “Buy Recycled Program” is being implemented across the AF and we must attempt to meet or exceed the EPA Recommended Material Advisory Notice (RMAN) recycled-content recommendations unless the item:

1. Is too expensive,
2. Does not meet technical performance requirements,
3. Is not available competitively from two or more sources, or
4. Is not available in a timely manner.

All recycled-content specifications for EPA Comprehensive Procurement Guidelines (CPG) Items must correspond exactly to recommendations in EPA's RMAN. The recommendations in this Tool include the RMAN requirements current as of August 1997.

It is also important to select building materials based on maintainability and operability. Examples include selecting durable finishes that don't require painting, like integral color coat exterior stucco; choosing floor coverings which are easily cleaned without harsh chemicals; or specifying long-lasting, low maintenance roofing materials such as metal or concrete tile.

Life cycle analysis techniques for selecting building materials based on their environmental impacts are detailed in Section C of the "Sustainable Building Technical Manual."

Recommended Volatile Organic Compound (VOC) limits are identified throughout this Tool. Before specifying these limits, check your local air quality management district regulations. Some geographical regions have specific, mandatory VOC content requirements.



## **Reference Documents**

Refer to Chapter 9, Contract Document Development: Building Materials for a list of reference documents. A discussion of useful references for specification development is included later in this Tool.

## **Certifications**

Vendor estimates and certification of use of EPA Guideline Items will be tracked in accordance with Federal Acquisition Regulation (FAR) requirements and supplements. Personnel are required to ensure that the latest FAR guidance is used when purchasing EPA Guideline Items. Verification is the responsibility of all users, but is primarily the responsibility of Quality Assurance Representatives and Construction Contracting Inspectors.

FAR provision 52.223-8, Estimate of Percentage of Recovered Material for EPA Designated Items to be Used in the Performance of the Contract is required on solicitations greater than the simplified acquisition threshold (\$100,000). Failure to meet the EPA minimum recycled-content standards may make an offeror's proposal non-responsive.

Vendors shall certify that the percentage of recovered material to be used in the performance of the contract will be at least the amount required by applicable specifications or other contractual requirements. Vendors shall use FAR 52.223-9, Certification of Percentage of Recovered Material Content for EPA Designated Items Used in Performance of the Contract, to meet this requirement. Certifications shall be sent by contractors to the base environmental management function for tracking purposes.

## **Developing Specifications Including Sustainable Provisions**

Construction Specification Institute (CSI) Division 1 covers general administrative and procedural issues. This is the place to indicate the Government's commitment to sustainable construction, identify specific environmental goals or areas of concern, and require the Contractor to prepare environmental management plans. Section 01500, Construction Waste Management, may be used to require recycling of construction and demolition (C&D) debris.

CSI Divisions 2 through 16 should incorporate sustainability requirements corresponding to the Sustainability Goals set by the project management team early in the design process. Specific ideas are presented in the remainder of this Tool. Additional references to help develop or modify project specifications include:

- Sustainable Building Technical Manual. Chapter 17 includes templates for Section 01150, Environmental Procedures, and a generic template for incorporating environmental considerations into Divisions 2 through 16.
- WasteSpec: Model Waste Specification for Construction Waste Reduction, Reuse and Recycling. Includes model specification language for each of the 16 divisions. It addresses waste reduction techniques during construction; reuse of construction waste material on the construction site; salvage of C&D debris for resale or reuse by others; return of unused materials to vendors for credit; and delivering C&D debris to others for remanufacture into new products. Each suggested specification provision is annotated to show its probable effect on project cost.
- GreenSpec: Guideline Specifications for Environmentally Considered Building Materials and Construction Methods. Includes model specification language for each of the 16 divisions. It is intended to provide environmental information to "cut and paste" into existing project specifications. Information includes the main environmental considerations for different building materials and why they are important.

## **Recommendations for Building Material Selection**

The following list is organized by CSI Divisions and provides considerations that will influence selection and specification of building materials. Actions are recommended based on the language used below:

1. Consider: Consider the recommendation, and implement as a requirement in the specification if cost, technical performance or availability do not prohibit its use.
2. Express Preference For: Include language in appropriate sections of the specification expressing the Government's preference for specific types of environmentally preferable materials, provided they are technically suitable, available, and cost effective. Specification language that expresses a preference for certain materials, and requires a submittal to verify whether the preference has been met, is suggested when you believe the products are technically suitable but lack definite information about local availability or price differentials. Use "preference" language to try to obtain cutting edge products and technologies, and convert it to "required" specification language in future projects if the results are good.
3. Certify: Include in the appropriate sections of the specification as a requirement and require the contractor to submit a written document certifying that the requirement has been met, unless precluded by cost, technical performance or availability. The submittal requirement should be noted in the "submittal" section of each appropriate specification section. It is suggested that Certifications only be used when required by the FAR.

**Symbols to the left of each recommendation indicate whether it is mandatory or optional, as follows:**

- ①** Includes an EPA Guideline Item. Recycled material content meeting EPA's recommendations is currently required unless precluded by cost, technical performance, or availability. Certification is required.

- ② Includes a proposed addition to EPA’s Guideline Items. Recycled content will be required for these products on 13 Nov 98 (one year from publication of EPA’s “CPG II” final rule).
- ③ Best Management Practice. Specifying these materials or practices will contribute to the project's overall sustainability but is not legally required.

## **A. DIVISION 01 - GENERAL REQUIREMENTS**

- ① 1. Include a general statement expressing the Government's preference for recycled-content building materials in accordance with EPA's Comprehensive Procurement Guidelines.
- ③ 2. Consider requiring the construction contractor to prepare and submit plans for hazardous material and waste management, solid waste management and recycling of construction and demolition (C&D) debris, and stormwater pollution prevention management. Check with the environmental flight for local policies and direction.

## **B. DIVISION 02 - SITEWORK**

### **02200 - Earthwork**

- ③ 1. Consider stockpiling and reusing existing topsoil on site to reduce need for importing topsoil.
- ③ 2. Consider composting land clearing debris for use on site. Participate in established base or regional composting programs to process land clearing debris and obtain compost for use in the project.

3. Consider specifying geotextiles that are made from recycled plastic soda bottles.

## **02500 - Paving and Surfacing (Pedestrian)**

- ① 1. Certify that playground surfaces and running tracks include 90 to 100% recycled postconsumer rubber or plastic, based on dry weight of raw materials.
- ③ 2. Specify bricks or pavers manufactured in the geographic region of the proposed facility.
- ③ 3. Consider the use of recovered brick and pavers whenever possible.
- ③ 4. Consider the use of bricks or pavers containing petroleum contaminated soil whenever possible.

## **02550 - Paving and Surfacing (Vehicle)**

- ① 1. Certify that concrete paving contains fly ash or ground granulated blast furnace slag in accordance with requirements for EPA Guideline Items. See recommendations under Section 03000 - Concrete.
- ③ 2. Consider use of crushed recycled concrete as subbase fill for pavement where regionally available. Consider requiring the contractor to crush and use concrete debris from site demolition rather than landfilling it.
- ③ 3. Consider asphalt paving containing recycled asphalt where regionally available.
- ③ 4. Consider the use of petroleum contaminated soils in asphalt paving.
- ③ 5. Consider pervious paving systems as an alternative to impervious systems; e.g., porous asphalt or concrete (constructed with "open-graded" aggregate lacking fine particles) instead of traditional asphalt. Reserve impervious

pavement use for special situations such as swelling soils, highly plastic soils, or steep slopes.

- ② 6. Express preference for parking wheel stops containing recycled plastic or rubber, or made from concrete containing recycled materials.

#### **02860 - Playfields and Equipment**

- ③ 1. Consider specifying playsets, playground equipment, soccer and basketball goals made from recycled plastics, steel and aluminum.

#### **02870 - Site Furniture**

- ③ 1. Consider specifying benches, picnic tables, planters, bike racks, refuse containers and other items that are made of recycled materials such as plastic, fiberglass or metals.

#### **02900 - Landscaping**

- ① 1. Certify that paper-based hydraulic mulch contains 100% post consumer recycled content.
- ① 2. Certify that wood-based hydraulic mulch contains 100% recovered wood and/or paper.
- ① 3. Certify that compost is made from yard trimmings, leaves and/or grass clippings.
- ③ 4. Express preference for decorative landscape mulch (bark or wood chips) that is made from waste wood or land clearing debris. Consider requiring the contractor to shred site clearing debris and unpainted and untreated wood demolition debris to use as mulch for landscaping the completed

project; or consider doing this in-house if the base has access to a wood chipper.



## **C. DIVISION 03 - CONCRETE**

- 1** 1. Certify that cement and concrete contain fly ash or ground granulated blast furnace slag in accordance with EPA recommendations. Rather than setting percentage content requirements, EPA refers designers to the following standards: ASTM C 595, ASTM C 150, AASHTO M 240, ASTM C 618, ASTM C 311, ASTM C 989, AASHTO M 302, and ACI Standard Practice ACI 226R1. For further information refer to EPA Fact Sheet, "1996 Buy-Recycled Series: Construction Products." When concrete is used as an architectural finish material, the requirement may be waived to ensure color uniformity.
- 3** 2. Consider specifying use of recycled paper tubes for forming cylindrical concrete columns.

## **D. DIVISION 04 - MASONRY**

### **04210 - 04220 - Brick Masonry / Concrete Unit Masonry (CMU)**

- 3** 1. Consider the use of CMU containing recycled materials such as polystyrene, wood fibers or fly ash.
- 3** 2. Express preference for brick and CMU manufactured in the geographic region of the proposed facility.
- 3** 3. Consider the use of brick containing petroleum contaminated soil whenever possible.
- 3** 4. Consider the use of recovered brick whenever possible.

## **04440 - 04475 - Stone Products**

- ③ 1. Express preference for stone quarried in the geographic region of the proposed facility.

## **E. DIVISION 05 - METALS**

- ③ 1. Express preference for recycled content in all steel used for reinforcing (rebar).
- ③ 2. Consider specifying metal studs with recycled steel content in place of wood framing.
- ③ 3. Consider specifying nails and fasteners manufactured from re-melted steel.
- ③ 4. Consider using metal mesh infill panels in place of pipe railings for fire stairs.
- ③ 5. Use electrostatic powder coat factory finish on metal surfaces to the greatest extent possible.

## **F. DIVISION 06 - WOOD AND PLASTICS**

### **06100 - 06124 - Wood Products**

- ③ 1. Consider specifying wood and wood products that do not appear on endangered wood species lists of the Woodworkers Alliance for Rainforest Protection (WARP), and the Convention on International Trade and Endangered Species (CITES).

- ③ 2. Express preference for solid and veneer wood products originating from a sustainable managed forest certified by Scientific Certification Systems (SCS) or the Rainforest Alliance.
- ③ 3. Consider using engineered wood joists, finger-jointed timbers and/or glued laminated timbers which consist of smaller wood pieces bonded together to use wood resources more efficiently.
- ③ 4. Express preference for plywood wood stock that originates from a sustainable managed forest certified by SCS or the Rainforest Alliance.
- ③ 5. Consider specifying all plywood to be urea-formaldehyde free (specify exterior grade plywood). Interior grade plywood is manufactured with urea-formaldehyde adhesives that emit higher formaldehyde concentrations.
- ③ 6. Consider specifying Medium Density Fiberboard (MDF) used as blocking, millwork, casework substrate, etc. to meet the American National Standard Institute (ANSI) limits on formaldehyde as stated in ANSI 208.2-1994 (<.30 parts per million -PPM).
- ③ 7. Consider specifying particleboard used as blocking, millwork, casework substrate, underlayment, door cores, etc. that meets the ANSI limits on formaldehyde as stated in ANSI 208.1-1993 (<.30 PPM for particleboard, general or <.20 PPM for particleboard flooring).
- ③ 8. Consider specifying sheathing manufactured from recycled paper or wood fibers in place of plywood, where feasible (and see #9 below).
- ① 9. Certify that structural fiberboard used in the project contain 80 to 100% total recovered materials (by weight) and/or laminated paperboards contain 100% postconsumer recovered paper.

- ③ 10. Consider specifying plastic or plastic composite lumber made with recycled materials for non-structural applications such as fences, decks and trellises.
- ③ 11. Consider using reclaimed or remilled timbers for unexposed framing, trim, etc. Timber brokers offer salvaged lumber for sale.
- ③ 12. Consider specifying ACQ (ammonium-copper-quaternium) treatment in lieu of the more toxic CCA (chromated copper arsenate) pressure treatment, when pressure treated lumber is required.

#### **06240 - Plastic Laminate**

- ③ 1. Consider specifying plastic laminates to be installed with water-based, low-Volatile Organic Compound (VOC) contact cement, cold press or Polyvinyl Acetate (PVA) glues, with less than 200 grams of VOC per liter (1.70 lb./gal) of adhesive.
- ② 2. Express preference for shower compartments and toilet partitions made from recycled plastic or steel.
- ③ 3. Consider specifying bath countertops made from recycled plastic.

#### **06410 - Custom Casework**

- ③ 1. Consider specifying millwork and casework adhesives that are water-based, low-VOC adhesives, with less than 150 grams of VOC per liter (1.25 lb./gal) of adhesive.
- ③ 2. Consider specifying transparent wood finish systems utilizing waterborne acrylic sealers with waterborne polyurethane finish coats, or oil-modified polyurethane

sealers and finish coats with less than 450 grams of VOC per liter (3.75 lb./gal) of finish.

## **G. DIVISION 07 - THERMAL AND MOISTURE PROTECTION**

### **07210 - Building Insulation**

- 3** 1. Consider specifying cellulose or recycled cotton insulation which are generally less toxic and require less production energy than fiberglass. Mineral fibers and glass fibers are possible carcinogens.
- 1** 2. Certify that cellulose insulation (if used) contains over 75% post-consumer recycled paper by weight.
- 3** 3. Consider specifying slag (rock) wool insulation for firesafing (and see #4 below).
- 1** 4. Certify that rock wool insulation (if used) contains over 75%-recycled slag by weight.
- 3** 5. Consider specifying foam insulation products that do not require CFC or HCFC blowing agents for production (e.g. expanded polystyrene - EPS). Specify products including recycled polystyrene if regionally available.
- 3** 6. Consider specifying extruded polystyrene for thermal insulation that is susceptible to water (at the perimeter foundation, at the roof, and at exterior brick or CMU cavity walls). Extruded foams offer higher performance than expanded foams. Specify products including recycled polystyrene if regionally available.
- 1** 7. Certify that fiberglass insulation (if used) contains at least 20 to 25% recovered glass cullet by weight.
- 1** 8. Certify that polyisocyanurate and polyurethane rigid foam insulation used in the project contains over 9%-recovered materials by weight.

- ① 9. Certify that polyurethane foam-in-place insulation used in the project contains over 5%-recovered materials by weight.
- ① 10. Certify that glass fiber reinforced insulation (if used) contains over 6%-recovered materials by weight.
- ① 11. Certify that phenolic rigid foam board insulation (if used) contains over 5%-recovered materials by weight.
- ① 12. Certify that perlite composition board insulation (if used) contains over 23% post-consumer recycled paper content by weight.
- ③ 13. Consider specifying cellular glass insulation where its increased compressive strength justifies its added cost.
- ③ 14. Consider specifying lightweight insulating concrete where its ability to perform structural, insulative, acoustic and fire resistive functions justifies its additional cost.

#### **07510 - Built -Up Bituminous Roofing**

- ③ 1. Consider specifying asbestos-free materials for roofing, mastics, etc.
- ③ 2. Consider specifying Atactic Polypropylene (APP) and Polyalphaolefin (PAO) modified bitumen instead of styrene-butadiene-styrene modified bitumen.
- ③ 3. Consider specifying heat-welding techniques instead of chemical adhesives and hot asphalt. If chemical adhesives are used, specify low-VOC products.

- ③ 4. Consider specifying mechanical fasteners to attach rigid insulation, fiberboard and other backing materials if the substrate will allow.
- ③ 5. Consider a low emissivity, light colored, reflective cap sheet for installations where the final facility will experience a net cooling load.

### **07530 - Single-Ply Membrane Roofing**

- ③ 1. Consider specifying elastomeric roofing material containing recycled tire rubber and reinforcing fiber containing recycled Polyethylene Terephthalate (PET).
- ③ 2. Consider specifying mechanically fastened installation unless the climate is suitable to ballast roofing systems, or the roof contains such complexity that a fully adhered system is the only practical solution. Look at EPDM Roofing. See ETL 90-8: Guide Specifications for Ethylene Propylene Diene Monomer (EPDM) Roofing, 17 Oct 90.
- ③ 3. Consider specifying hot air heat welding for thermoplastic materials. For thermoset materials, specify low VOC adhesives.
- ③ 4. Consider specifying a low emissivity, light colored, reflective membrane for installations where the final facility will experience a net cooling load and the roofing system is non-ballasted.
- ③ 5. Express preference for chlorosulfonated polyethylene or olefin based materials instead of those made with PVC when specifying thermoplastic roofing materials.

### **07610 - Metal Roofing**



- ③ 1. Consider specifying batt insulation as a substitute for rigid insulation whenever desired R-values can be attained.
- ③ 2. Express preference for roofing materials that do not contain lead.
- ③ 3. Express preference for lead-free solder if using solder.

#### **07901 - Joint Sealants**

- ③ 1. Consider requiring MSDS submittal and avoid products that contain mercury, butyl rubber, neoprene, SBR (styrene butadiene rubber) or nitrile.
- ③ 2. Consider specifying acrylic, silicone or siliconized acrylic low-VOC sealants for all appropriate interior applications. Water-based silicone sealants adhere well to porous and semi-porous materials but are not recommended for glass, metal and ceramic. Water based silicone sealants should not contain more than 50 grams per liter (g/L) (.40 lb./gal) of VOCs. Other sealants should not contain emittable VOCs in excess of 250 g/L (2.10 lb./gal).
- ③ 3. Express preference for compressible foam joint fillers, polyester polyurethane foam impregnated with neoprene rubber or acrylic ester styrene copolymer, that are not manufactured with chlorofluorocarbon (CFC) blowing agents.

### **H. DIVISION 08 - DOORS AND WINDOWS**

#### **08111 - 08125 - Doors and Frames (Steel and Aluminum)**

- ③ 1. Consider specifying electrostatic powder coat factory finish to the greatest extent possible.

- ③
  2. Consider specifying water-based high performance acrylic for doors and frames that are painted on site.

## **08212 - Flush Wood Doors**

- ③ 1. Consider specifying ANSI 208.1-1993 formaldehyde limits as a requirement for all doors having particleboard cores.

## **I. DIVISION 09 - FINISHES**

### **09250 - Gypsum Drywall**

- ③ 1. Express preference for gypsum board containing recycled or synthetic gypsum and having facing paper manufactured from recycled newsprint.
- ③ 2. Consider specifying low-VOC joint compound, less than 20 grams of VOCs per liter (.15 lb./gal) of product.
- ③ 3. Consider specifying that multi-layer gypsum board applications are screw attached and not laminated with adhesives.
- ③ 4. Consider specifying paper joint tape to be used instead of fiberglass tape.

### **09300 - 09400 - Tile and Terrazzo**

- ③ 1. Consider specifying terrazzo made with cement and crushed stone. Avoid epoxies as they contain hazardous components.
- ③ 2. Consider specifying tiles made with recycled glass or with feldspar waste from mining.
- ③ 3. Consider specifying tile underlayment board made with recycled materials.

## 09545 - Special Ceiling Surfaces

- ① 1. Certify that cellulosic fiber ceiling tiles contain 100% postconsumer recovered paper. If specifying ceiling tiles made with mineral fiber instead, preference should be expressed for recycled material content, but certification is not required.
- ③ 2. Consider specifying non-absorptive core panels and tiles in moist or high humidity areas. For food service areas specify only USDA approved Fiberglass Reinforced Plastic (FRP) panels.
- ③ 3. Consider specifying steel grid system in dry areas.
- ③ 4. Consider specifying aluminum grid system in locations subject to moisture or high humidity.

## 09557 - Wood Flooring

- ③ 1. Consider specifying veneered or laminated products made with recycled chipboard cores.
- ③ 2. Consider specifying reclaimed and remilled timbers as flooring material.
- ③ 3. Consider specifying zero-VOC adhesives for wood flooring.
- ③ 4. Consider specifying waterborne low-VOC stains and adhesives.
- ③ 5. Consider future salvageability when designing wood flooring systems. Steel-track systems and edge gluing are easiest to salvage, followed by nailing. Try to avoid glue-down installations except for parquet flooring, where it is required.

## **09660 - 09665 - Resilient Tile and Sheet Flooring**

- ③ 1. Consider specifying flooring products that are not made of solid vinyl. If vinyl flooring products are used, specify VCT (vinyl composition tile) for its reduced Polyvinylchloride (PVC) content and low VOC emissions or its equivalent in sheet goods.
- ③ 2. Consider specifying linoleum, which is made with renewable materials such as linseed oil, cork, wood dust and jute. Linoleum is also highly durable.
- ③ 3. Consider specifying adhesives that are water-based with low-VOC, less than 250 g/L (2.10 lb./gal), if using vinyl flooring.
- ③ 4. Consider specifying plastic or rubber floor tiles used in the project contain 90-100% recycled materials.
- ③ 7. Consider specifying flooring with sealed "low-maintenance" surfaces to reduce maintenance costs and usage of potentially irritating cleaning products.

## **09678 - Resilient Flooring Accessories**

- ③ 1. Consider specifying rubber base instead of vinyl base to avoid VOC emissions.
- ③ 2. Consider specifying adhesives for wall base that are water-based with low VOC, less than 150 g/L (1.25 lb./gal).

## **09685 - 09690 - Carpet (roll goods and tile)**

- ① 1. Certify polyester carpet contains at least 25% postconsumer recycled PET plastic (if used). Polyester carpet should be considered for all low and medium wear applications.
- ③ 2. Consider specifying carpet from manufacturers with an operating recycling program that does not contribute significantly to landfills. Nylon 6 fiber is recyclable. Some manufacturers recycle their own scraps while others take back used products for recycling.
- ③ 3. Consider specifying solution dyeing of a branded synthetic fiber (nylon 6 or nylon 6.6) for color durability, uniformity, and availability.
- ③ 4. Consider specifying fusion bonded or needle punched carpets that are made without latex and have low indoor air pollution potential. Specify woven construction only in areas of extreme traffic or requiring special pattern definition. If using latex-bonded carpets, consider requiring contractor to submit emissions test results from the manufacturer and select carpets having a VOC emission rate less than 0.5 milligrams per square meter. This is the voluntary limit agreed to by EPA and the carpet industry.
- ③ 5. Consider specifying carpet tile, which is resource efficient since only the worn tiles need to be replaced. Specify carpet tile installation in grid method or free lay (where recommended by manufacturer).
- ③ 6. Consider specifying carpet manufacturer recommended adhesive that is water based and contains less than 150 grams of VOC per liter (1.25 lb./gal) if an adhesive is required for installation. Certify installation according to carpet manufacturer recommended frame or perimeter adhesive pattern method. Full field glue-down should be avoided except for carpet with an integral dry film adhesive back.

- ③ 7. Consider specifying carpet manufacturer recommended seam sealer that consists of less than 50 grams of VOC per liter (.40 lb./gal), or recommend heat welded seaming if a seam sealer is required.
- ③ 8. Consider specifying that broadloom carpet shall be installed without adhesives where low intensity of use allows. Consider alternate fastening methods such as "hook and loop" (looped carpet backing fastens to hook tape).
- ① 9. Certify that floor underlayments contain 80 to 100% recycled materials (if fiberboard is used) or 100% postconsumer recovered paper (if laminated paperboard is used).
- ③ 10. Consider specifying carpet pad that is made from recycled tire rubber or from recycled fibers from textile mill waste.

#### **09900 - Paint**

- ③ 1. Consider specifying water based paints throughout, unless special requirements preclude their use. Use water based latex for general use and water based high performance acrylic paint where greater durability is required. Specify solvent-based paint only where its special properties are required.
- ③ 2. Consider limiting VOC content for solvent based paints to less than 380 grams of VOC per liter (3.20 lb./gal) of paint. Calculation of VOC content excludes water and tinting compounds added at point of sale.
- ③ 3. Consider limiting VOC content for water based paints to less than 150 g/L (1.25 lb./gal) for primers and flat paint, and less than 250 g/L (2.10 lb./gal) for other types.
- ② 4. Express preference for recycled-content latex paints for interior use.

- ③ 5. Consider specifying paints that do not contain heavy metals such as lead, mercury, cadmium, and hexavalent chromium (chromium VI). Lead paints may not be used in residential construction. Other uses should be carefully reviewed and avoided whenever possible.
- ③ 6. Consider specifying paints that do not include formaldehyde, halogenated solvents, or more than 10% by weight of aromatic hydrocarbons (an organic solvent with a benzene ring in its molecular structure).
- ③ 7. Consider specifying paints having a flash point greater than 60 degrees C (140 degrees F) so that extra paint will not be classified as hazardous waste due to ignitability.

#### **09970 - 09976 - Wallcoverings**

- ③ 1. Consider specifying non-vinyl wallcovering. During the manufacturing process vinyl chloride, a known carcinogen is released. Alternative materials to vinyl wallcoverings include multi-color paints and textured and multi-colored coatings.
- ③ 2. Consider selecting wallcoverings made with recycled materials. Hard, soft and tackable surfaces are available including textiles, metal, wood, and stonelike composites.
- ① 3. Certify that sound-deadening board contains 80 to 100% recycled materials (if fiberboard is used) or 100% postconsumer recovered paper (if laminated paperboard is used).
- ③ 4. Consider specifying adhesives with low VOC, less than 150 g/L (1.25 lb./gal), and which do not allow mildew or microbial growth.

#### **J. DIVISION 10 - SPECIALTIES**



## **10155 - Toilet and Shower Partitions**

- 2**
  1. Express preference for shower and restroom dividers containing recycled plastic or steel.

## **K. DIVISION 11 - EQUIPMENT**

Not Used.

## **L. DIVISION 12 - FURNISHINGS**

### **12600 - Furniture and Accessories**

- 3** 1. Express preference for wood furniture manufactured using wood from a sustainable source, if selecting wood furniture.
- 3** 2. Consider specifying furniture manufactured using low-formaldehyde or no-formaldehyde particleboard. Particleboards made with polyurea resin binder have the lowest emissions. Urea-formaldehyde outgasses the most and should be avoided.
- 3** 3. Consider specifying factory-applied, factory-cured coatings for wood furniture, preferably urethanes having minimal emissions.
- 3** 4. Consider selecting aluminum or steel furniture, which has a natural finish or has been powdercoated electrostatically. Metals are durable and recyclable.
- 3** 5. Consider specifying furniture that uses waterborne Polyvinyl Acetate (PVA) adhesives; hotmelts, which are 100% solid thermoplastics (no solvents needed); and/or water-based adhesives.
- 3** 6. Consider evaluating results of air emissions testing before selecting furniture. Some manufacturers provide emissions data for their products. There are no required limits for indoor air emissions; simply try to minimize them.

## **M. DIVISION 13 - SPECIAL CONSTRUCTION**

Not Used.

## **N. DIVISION 14 - CONVEYING SYSTEMS**

Not Used.

## **O. DIVISION 15 - MECHANICAL**

### **15060 - Pipes and Pipe Fittings**

- ③ 1. Consider specifying lead-free solder.
- ③ 2. Consider specifying recycled content plastic sewer pipe made from PVC or ABS resin.
- ③ 3. Consider specifying clay drain tile made with recycled materials such as municipal incinerator ash.

### **15400 - Plumbing**

- ③ 1. Consider specifying water saving toilets, urinals, lavatories and showerheads. Refer to MIL-HDBK-1165, Water Conservation, for a discussion of various options.
- ③ 2. Consider specifying energy and water saving appliances. Appliances are also discussed in MIL-HDBK-1165.

## **P. DIVISION 16 - ELECTRICAL**

### **16500 - Lighting**

- 3** 1. Consider minimizing the use of incandescent lighting. Specify high efficiency light sources (HID, compact fluorescent) maximum of 1.5 watts per square foot (W/SF) for common areas. Specify low-mercury fluorescent light tubes.
- 3** 2. Consider specifying electronic ballasts. Otherwise specify high efficiency high power factor magnetic ballasts. Specify ballasts that do not contain PCB material.
- 3** 3. Consider specifying light-emitting diode (LED) exit signs. These fixture use one to six watts compared to 40 watts in older models.
- 3** 4. Consider specifying occupancy sensors. Provide one sensor per 12 fixtures or per 600 to 800 square feet (SF). Specify daylighting control in areas with skylights or within 15 feet of large windows. Specify astronomical time clocks and photocells. Specify override switches on timers for all lighting circuits. Provide dual lighting control for all areas over 100 SF. Locate switches within controlled area. For large areas, such as warehouses, specify control panel with key map and with switches located on corresponding area controlled.
- 3** 5. Consider specifying solar powered exterior lighting for streets, parking, walkways, trails and parks.

## **APPENDIX D**

### **LIFE CYCLE COST ANALYSIS REFERENCE TOOL**

#### **Introduction**

Life Cycle Cost evaluations account for investment costs (first cost), operation and maintenance costs, repair and replacement costs, salvage values, energy costs and other effects that are important for the long-term cost effectiveness of a decision. Unless otherwise stated by Air Force Instructions, all dollar amounts are estimated in constant dollars, with a discount rate of 7 per cent. The actual price of energy at the time the life cycle cost evaluation is conducted is used to establish a “base-year” energy cost. The study period for a new facility design or a facility retrofit should not exceed the lesser of 25 years or the period of intended use of the facilities; for a leased facility it should not exceed the lesser of 25 years or the effective remaining term of the lease.

#### **Reference Documents**

Access the following Reference Documents for the Tools to perform Life Cycle Cost Analysis:

Air Force Regulation (AFR) 178-1

Building Loads Analysis and Systems Thermodynamics (BLAST)  
energy computer model

10 Code of Federal Regulations (CFR) 436, Part A, Federal Energy Management and Planning Programs, Subpart 1 – Methodology and Procedure for Life Cycle Cost Analyses

Memorandum of Agreement (MOA) on Criteria/Standards for Economic Analyses/Life Cycle Costing for MILCON Design, March 1996

Life Cycle Cost in Design (LCCID)

National Bureau of Standards (NBS) Handbook 135, Life Cycle Costing Manual for the Federal Energy Management Program: a guide for evaluating the cost effectiveness of energy conservation and renewable energy projects

VisualDOE2.5, computer model, address: <http://www.eley.com>

ETL 83-9: Insulation, 14 Nov 83

ETL 94-2: Utility Meters in New and Renovated Facilities, 10 Jun 94

ETL 94-4: Energy Usage Criteria for Facilities in the Military Construction Program (MCP), 19 Aug 94

AFEPPM 96-4: Investment Opportunity for Energy and Water Conservation Projects, 14 Feb 96

**Table 1-1: Suggested LCCA Applications**

<b>Stages/Phases</b>	<b>Planning</b>	<b>Pre-Contract</b>	<b>Requirements Analysis</b>	<b>Project Definition</b>	<b>Contract</b>
Building Reuse or New Construction	<b>x</b>				
On-Site Wastewater Treatment	<b>x</b>		<b>x</b>		<b>x</b>
Graywater System	<b>x</b>		<b>x</b>		<b>x</b>
Photovoltaics	<b>x</b>			<b>x</b>	<b>x</b>
Passive Solar Strategies				<b>x</b>	<b>x</b>
Building Envelope and Insulation				<b>x</b>	<b>x</b>
Automated Lighting Controls				<b>x</b>	<b>x</b>
HVAC Systems				<b>x</b>	<b>x</b>
Appliances/Equipment				<b>x</b>	<b>x</b>
Energy Management and Control Systems				<b>x</b>	
Energy Retrofits for Facility Renovation				<b>x</b>	<b>x</b>
Submetering			<b>x</b>		
Low Maintenance Landscaping					<b>x</b>
Recycling Center	<b>x</b>				<b>x</b>
Construction Waste Recycling					<b>x</b>

## APPENDIX E

### PROJECT COMMISSIONING TOOL

#### **Introduction**

Heating, Ventilation and Air Conditioning (HVAC) commissioning is required for all Air Force construction projects. Executive Order (EO) 12902, Section 306 (a) (3) requires commissioning. Full systems commissioning, which is outlined in this Tool, involves the systematic documentation and verification of the performance of all facility systems including HVAC, Plumbing, Fire Protection, Electrical, Lighting and Life Safety Systems. Full systems commissioning provides many benefits as it forms a bridge between the design team and the ultimate Operations and Maintenance team, and it assures facility owners that systems are properly installed. This tool provides a summary of all of the steps in the full systems commissioning process.

#### **Reference Documents**

ASHRAE Guideline 1-1989: Guideline for Commissioning HVAC Systems,  
address: <http://www.ashrae.org/text.htm>

EO 12902, Energy Efficiency and Water Conservation.

ETL 89-2: Standard Guidelines for Submission of Facility Operating and Maintenance Manuals, 23 May 89.

ETL 90-10: Commissioning of Heating, Ventilating, and Air Conditioning (HVAC) Systems Guide Specification, 17 Oct 90.



## **Action Items**

### **A. PLANNING**

- A.1. Budget for full systems commissioning and for the preparation of Operations and Maintenance (O&M) Manuals; include in approved DD Form 1391.

### **B. PRE-CONTRACT**

- B.1. Define the commissioning process and assign responsibilities.
- B.2. Establish documentation procedures for the commissioning process.

### **C. REQUIREMENTS ANALYSIS**

- C.1. Document occupancy requirements and design criteria, and define design conditions.

### **D. SCHEMATIC DESIGN**

- D.1. Define building zones and utilization and develop systems descriptions. Include in commissioning documentation.

### **E. CONTRACT DOCUMENT DEVELOPMENT**

- E.1. Develop commissioning report that documents design conditions and provides detailed system descriptions. Define roles during the commissioning process for the owner, design professional, contractors, vendors, manufacturers and others as required.
- E.2. Develop commissioning specification for construction documents. Define verification procedures and documentation requirements. Require construction contractor to provide Equipment Operating, Maintenance and Repair Manuals and train O&M staff.

## **F. CONSTRUCTION**

- F.1. Operate equipment and verify the Sequence of Operation, including full load, part load and emergency operation.
- F.2. Witness and document all test procedures for piping, ductwork, equipment startup, adjusting testing and balancing and calibration. Perform all corrective measures as necessary.
- F.3. Perform Functional Performance Tests to validate operation of all equipment, systems, subsystems and system interfaces. Use separate checklist for each piece of equipment.
- F.4. Provide Equipment Operating, Maintenance and Repair Manuals to the Base Civil Engineer (BCE). Manuals shall include a copy of the Commissioning Plan and Functional Performance Test results.
- F.5. Create System Operating Manuals. Document procedures for dealing with abnormal or emergency conditions.
- F.6. Train facilities O&M personnel on the use of the systems and on how to use the O&M manuals.
- F.7. Document all design or installation changes that occur during the construction phase.
- F.8. Specify pre-occupancy baseline Indoor Air Quality (IAQ) testing. Test for indoor air concentrations of CO<sup>2</sup>, total VOCs and particulates.

## **G. OPERATIONS AND MAINTENANCE**

- G.1. Document changes to usage, equipment, loads or occupancy.
- G.2. Provide notification to building O&M crew of planned alterations.
- G.3. Periodically re-test systems. Use a Functional Performance Test as a guideline.

## APPENDIX F

### POST-OCCUPANCY EVALUATION TOOL

#### **Introduction**

Assessment provides verification from an outside source that significant improvements have been made in the environmental performance of the facility. The US Green Building Council, *LEED Building*<sup>™</sup> Rating System, a consensus document that represents the current thinking of a wide cross section of experts in the Sustainable Building field, has been selected for use. This is an extremely sophisticated rating system and is being widely used by many organizations, including the United States State Department.

The US Green Building Council is a non-profit coalition for the building industry, comprised of product manufacturers, facility owners and managers, architects and engineers, environmental organizations, utilities, state and local governments, contractors and builders, building control service contractors and research institutes.

The system has undergone extensive review by all members of the council, and many local governments, agencies and other organizations have expressed a desire to adopt the system. The first edition of the *LEED Building*<sup>™</sup> Rating System has been developed for assessment of commercial buildings in the United States. It is designed for use by the Facility Manager in conjunction with the Engineering Flight. A summary of the issues contained in the rating system follows; for descriptions of the individual measures, the *LEED Building*<sup>™</sup> Rating System should be consulted (the World Wide Web address is provided below).

#### **Reference Documents**

ASHRAE standards: <http://www.ashrae.org/text.htm>

Building Environmental Performance Criteria (BEPAC), Canada, address:  
<http://www.iesd.dmu.ac.uk/bepac/default.htm>

Building Research Establishment Environmental Assessment Method (BREEAM), United Kingdom

Energy Policy Act of 1992

EPA, Lead in Drinking Water Protocol

EPA, Safe Drinking Water Act

Hong Kong Building Environmental Assessment Method (HK-BEAM), Centre of Environmental Technology, Limited, 77 Tat Chee Avenue, Kowloon, Hong Kong, (852) 2784.6699 fax.

US Green Building Council, (Leadership in Energy and Environmental Design) *LEED Building*<sup>™</sup> Rating System.

### **LEED Building Prerequisites**

Asbestos Avoidance or Management  
Building Commissioning  
Elimination of CFCs  
Energy Efficiency  
Indoor Air Quality  
Smoking Ban  
Storage & Collection of Occupant Recyclables  
Thermal Comfort  
Water Conservation  
Water Quality - Lead

### **LEED Building Rating System Credits**

#### **Building Materials (7 Credits)**

1 or 2 credits for low VOC materials (1 credit for 1 or 2 measures;  
2 credits for 3)

Limit VOC content in adhesives.

Limit the VOC content in architectural sealants.  
Limit the VOC content in paints and coatings.

- 1 credit for use of local materials
- 1 credit for resource reuse
- 1 credit for advanced resource reuse
- 1 credit for recycled content
- 1 credit for advanced recycled content

### **Construction Waste Management (2 Credits)**

- 1 credit for management plan
- 1 credit for advanced management plan

### **Energy (10 Credits)**

Energy Efficiency (7 Credits) (Note: Points are NOT additive, except for Heat Recovery, Natural Ventilation and Bonus Credit)

1 credit for:

EPA Green Lights Partnership  
Or  
California Title-24 Lighting

2 credits for:

EPA energy star building certification  
Or  
exceeding ASHRAE 90.1 by 20%.

3 credits for exceeding ASHRAE 90.1 by 30%.

4 credits for exceeding ASHRAE 90.1 by 40%

5 credits for exceeding ASHRAE 90.1 by 50%

1 additional credit for natural ventilation, heating and cooling

1 additional credit for waste-heat recovery system

### **Renewable/Alternative Energy (3 Credits)**

1 credit for 10% of building energy from on site renewable sources  
2 credits for 20% of building energy from on site renewable sources  
3 credits for 30% of building energy from on site renewable sources

### **Existing Building Rehabilitation (2 Credits)**

- 1 credit for maintaining 75% of the structural shell when renovating an existing building
- 2 credits for maintaining 100% of the structural shell when renovating an existing building

### **Indoor Air Quality (3 Credits)**

- 1 credit for construction IAQ management plan
- 1 credit for advanced construction IAQ management plan
- 1 credit for permanent air monitoring system

### **Landscaping (2 Credits)**

- 1 credit for erosion control
- 1 or 2 credits for reducing heat islands  
(1 credit for 1 or 2 measures; 2 credits for 3)
  - shade cover
  - reflective roofing materials
  - reflective surface

### **LEED-Certified Designer (1 Bonus Credit)**

- 1 bonus credit for using a LEED-certified designer

### **Occupant Recycling Equipment (1 Credit)**

- 1 credit for occupant recycling systems and equipment

### **Operations and Maintenance Facilities (2 Credits)**

- 1 credit for chemical storage areas
- 1 credit for architectural entryways

### **Ozone Depletion/CFCs (2 Credits)**

- 1 credit for eliminating CFC, HCFC and halon use in mechanical and fire suppression
- 1 credit for eliminating CFCs and HCFCs in building materials

### **Siting (3 Credits, plus 1 Bonus Credit)**

- 1 credit for reduced habitat disturbance or building rehabilitation
- 1 credit for site restoration
- 1 credit for infill development or building rehabilitation
- 1 bonus credit for brownfield development

### **Transportation (3 Credits, plus 1 Bonus Credit)**

- 1 or 2 credits for alternative transportation facilities (1 credit for 1 or 2 measures; 2 credits for 3 measures)
  - bicycle racks
  - shower and changing facilities
  - transit and pedestrian-friendly physical linkages or carpool parking
- 1 credit for efficient building location
- 1 bonus credit for alternative fueling facilities

### **Water Conservation (4 Credits)**

- 1 credit for water-conserving fixtures
- 1 credit for gray water recovery system
- 1 credit for water-conserving cooling towers
- 1 credit for water efficient landscaping

### **Water Quality (2 Credits, plus 1 Bonus Credit)**

- 1 credit for surface runoff filtration
- 1 credit for surface runoff reduction
- 1 bonus credit for biological waste treatment



## APPENDIX G

### CONSTRUCTION & DEMOLITION ECONOMICS WORKSHEET THE COST OF RECYCLING VS. THE COST OF DISPOSAL

	Date:
Project:	Prepared by:
Project size:	Project Cost:

PROCEDURES	RECYCLING	DISPOSAL
<b>1. Estimate Total Waste:</b> (refer to waste bills from similar type project; includes recyclables and nonrecyclables)	<b>a.</b> _____ tons	<b>aa.</b> _____ tons
<b>2. Determine Recoverable Materials:</b> <b>a. Wood</b> <b>b. Corrugated cardboard</b> <b>c. Metals</b> <b>d. Concrete/asphalt/brick/rubble</b> <b>e. Drywall</b> <b>f. Land-clearing debris</b>  <b>Total amount of recoverable materials</b>  <b>Total amount of nonrecoverable materials</b>	<b>a.</b> _____ tons <b>b.</b> _____ tons <b>c.</b> _____ tons <b>d.</b> _____ tons <b>e.</b> _____ tons <b>f.</b> _____ tons  <b>g.</b> _____ tons (add lines a through f) <b>h.</b> _____ tons (subtract line 2g from line 1a)	
<b>3. Determine Material-Handling Costs</b> <b>a.</b> Estimate additional hours to source-separate recoverable materials (2g) on job site  <b>b.</b> Determine labor rate for material handler (s)  <b>Total material-handling costs</b>	<b>a.</b> _____ hrs.  <b>b.</b> _____ \$/hr.  <b>c.</b> \$ _____ (multiply lines a and b)	
<b>4. Determine Market Value: (if self-hauling only)</b> Enter <b>revenues</b> generated from the sale of recyclables in parenthesis, i.e., (\$150)-these revenues will be subtracted from the total cost in step #8. Enter <b>costs</b> associated with recycling C&D debris <u>without</u> parenthesis, i.e., \$60-these costs will be added to the total in step #8.  <b>a. Wood:</b> Multiply market price/cost (\$____/ton) and amount from line 2a.  <b>b. Corrugated cardboard:</b> Multiply market price/cost (\$____/ton) and amount from line 2b.  <b>c. Metals:</b> Multiply market price/cost (\$____/ton) and amount from line 2c.  <b>d. Concrete/asphalt/brick/rubble:</b> Multiply market price/cost (\$____/tons) and amount from line 2d.  <b>e. Drywall:</b> Multiply market price/cost (\$____/ton) and amount from line 2e.  <b>f. Land-clearing debris:</b> Multiply market price/cost (\$____/ton) and amount from line 2f.  <b>g. Total market value for recycled materials</b>	<b>a.</b> \$ _____  <b>b.</b> \$ _____  <b>c.</b> \$ _____  <b>d.</b> \$ _____  <b>e.</b> \$ _____  <b>f.</b> \$ _____  <b>g.</b> \$ _____ (add/subtract lines a through f)	

## APPENDIX G CONSTRUCTION & DEMOLITION ECONOMICS WORKSHEET

<b>5. Estimate Transportation Costs:</b> <b>a. Self-Haul:</b> Estimate time to transport materials to market outlet(s) ____ hrs. Estimate hourly rate (vehicle and driver) to transport materials to appropriate market outlet(s) Vehicles \$____/hr. + Driver \$____/hr. = \$____/hr.  And/or  <b>b. Contracted Hauler:</b> Work with local hauler(s) to determine costs based on container fees and service charges  <b>c. Total transportation costs:</b>	<b>a.</b> \$ (multiply hourly rate by total hours)          <b>b.</b> \$ (Insert estimated cost)          <b>c.</b> \$ (add lines a and b)	<b>aa.</b> \$ (multiply hourly rate by total hours)          <b>bb.</b> \$ (insert estimated cost)          <b>cc.</b> \$ (add lines aa and bb)
<b>6. Determine Landfill Disposal Costs:</b> Determine where waste materials will be taken and disposal fees (\$____/ton).	<b>a.</b> \$ (multiply line 2h by disposal fee)	<b>aa.</b> \$ (multiply line 1aa by disposal fee)
<b>7. Other Taxes or Fees</b> (solid waste tax for disposal; sales tax for recycling)	<b>a.</b> \$	<b>aa.</b> \$
<b>8. Total Costs:</b> <b>a. Material-handling costs</b>  <b>b. Transportation cost</b>  <b>c. Landfill disposal costs</b>  <b>d. Other Taxes or Fees</b>  <b>e. Total market value for recycled materials</b> (subtract recycling revenues/add recycling costs)	<b>a.</b> \$ (insert amount from line 3c) <b>b.</b> + \$ (insert amount from line 5c) <b>c.</b> + \$ (insert amount from line 6a) <b>d.</b> + \$ (insert amount from line 7a) <b>e.</b> -/+ \$ (Insert amount from line 4g)	<b>bb.</b> + \$ (insert amount from line 5cc) <b>cc.</b> + \$ (insert amount from line 6aa) <b>dd.</b> + \$ (insert amount from line 7aa)
<b>NET COST:</b>	\$ (sum of a, b, c and d, then add or subtract e)	\$ (sum of bb, cc and dd)